N357204

8500A

instruction manual

FLUKE

FLUKE®

Instruction Manual

Model

8500A

Digital Multimeter

P/N 426536

JULY 1977

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Table of Contents

SECTION	TITLE	PAGE
1	**INTRODUCTION AND SPECIFICATIONS**	**1-1**
	1-1. INTRODUCTION	1-1
	1-3. DESCRIPTION	1-1
	1-4. Mainframe	1-1
	1-8. Options	1-1
	1-10. SPECIFICATIONS	1-1
2	**OPERATING INSTRUCTIONS**	**2-1**
	2-1. INTRODUCTION	2-1
	2-3. SHIPPING INFORMATION	2-1
	2-6. INSTALLATION	2-1
	2-8. Input Power Requirements	2-1
	2-10. Fuses	2-1
	2-12. OPERATING FEATURES	2-1
	2-14. OPERATING NOTES	2-1
	2-15. General	2-1
	2-18. Function Selection	2-4
	2-20. Error Codes	2-4
	2-22. DC Voltage Measurement	2-4
	2-24. Input Terminals	2-4
	2-26. Range Selection	2-4
	2-28. Modifier Selection	2-5
	2-37. Safety Warning Indications	2-5
	2-39. Control	2-6
	2-42. Memory	2-6
	2-51. Guarding	2-6
	2-54. Thermal EMF's	2-8
	2-56. Systems Use of the 8500A	2-8
3	**THEORY of OPERATION**	**3-1**
	3-1. INTRODUCTION	3-1
	3-3. BLOCK DIAGRAM DESCRIPTION	3-1
	3-4. Bus Structure	3-1
	3-10. Controller	3-2
	3-20. Front Panel	3-6

(continued on page ii)

TABLE OF CONTENTS, *continued*

SECTION		TITLE	PAGE
	3-22.	DC Signal Conditioner	3-6
	3-24.	Active Filter	3-6
	3-26.	Fast R^2 A/D Converter	3-7
	3-31.	CIRCUIT ANALYSIS	3-8
	3-32.	Introduction	3-8
	3-34.	Controller	3-8
	3-54.	Front Panel	3-12
	3-57.	DC Signal Conditioner	3-12
	3-61.	Filter/External References	3-12
	3-65.	Fast R^2 A/D Converter	3-16
4		**MAINTENANCE**	**4-1**
	4-1.	INTRODUCTION	4-1
	4-3.	SERVICE INFORMATION	4-1
	4-6.	GENERAL MAINTENANCE	4-1
	4-7.	Line Voltage Selection	4-1
	4-9.	Fuse Replacement	4-1
	4-11.	Module Installation and Removal	4-2
	4-13.	Front Panel PCB Removal and LED Replacement	4-3
	4-15.	Power Supply Removal	4-3
	4-17.	Power Supply Interconnect PCB Removal	4-3
	4-19.	Motherboard PCB Removal	4-3
	4-21.	Cleaning Instructions	4-3
	4-23.	PERFORMANCE TEST	4-3
	4-24.	Introduction	4-3
	4-28.	DC Performance Test	4-4
	4-31.	HIGH RANGE DC VOLTAGE TESTS	4-4
	4-37.	CALIBRATION PROCEDURES	4-6
	4-38.	Introduction	4-6
	4-40.	Preliminary Operations	4-6
	4-41.	Power Supply	4-7
	4-43.	DC Calibration Procedure	4-7
	4-50.	A/D Zero Adjustment	4-7
	4-51.	A/D Calibrator Settings	4-7
	4-53.	A/D Ladder Adjustments	4-8
	4-54.	Linearity Verification	4-8
	4-61.	TROUBLESHOOTING	4-9
	4-64.	Troubleshooting Notes	4-10
	4-68.	Module Disassembly	4-10
	4-71.	Troubleshooting Aids	4-10
5		**LIST OF REPLACEABLE PARTS**	**5-1**
	5-1.	INTRODUCTION	5-2
	5-4.	HOW TO OBTAIN PARTS	5-2
	5-7.	USE OF CODE EFFECTIVITY LIST	5-2
6		**OPTION AND ACCESSORY INFORMATION**	**6-1**
7		**GENERAL INFORMATION**	**7-1**
8		**SCHEMATIC DIAGRAMS**	**8-1**

List of Illustrations

FIGURE	TITLE	PAGE
Frontispiece		vi
2-1.	8500A Controls, Indicators, and Connectors	2-2
2-2.	Guard Connections	2-7
3-1.	8500A Block Diagram	3-1
3-2.	8500A Analog Signal Flow	3-2
3-3.	Background Software Process	3-3
3-4.	Foreground Software Process	3-4
3-5.	Controller Block Diagram	3-5
3-6.	DC Signal Conditioner Block Diagram	3-6
3-7.	Active Filter Block Diagram	3-6
3-8.	R^2 A/D Converter Block Diagram	3-7
3-9.	Timing Circuits	3-9
3-10.	Reset Logic	3-9
3-11.	Status Latch	3-10
3-12.	Wait Logic	3-10
3-13.	Internal Interrupts and INT Control	3-11
3-14.	ACK Logic	3-11
3-15.	Front Panel	3-13
3-16.	DC Signal Conditioner	3-14
3-17.	Filter/External Reference	3-15
3-18.	Fast R^2 A/D Converter (Analog)	3-17
4-1.	Connections For Low Range DC Voltage Tests	4-4
4-2.	Connections For High Range DC Voltage Tests	4-5

(continued on page iv)

LIST OF ILLUSTRATIONS, *continued*

FIGURE	TITLE	PAGE
4-3.	DC External Reference Test	4-6
4-4.	Power Supply Adjustments	4-6
4-5.	Power Supply Troubleshooting	4-16
4-6.	Controller Troubleshooting	4-17
4-7.	Front Panel Troubleshooting	4-18
4-8.	DC Signal Conditioner Troubleshooting	4-19
4-9.	Active Filter Troubleshooting	4-20
4-10.	R^2 A/D Converter Troubleshooting	4-21/4-22

List of Tables

TABLE	TITLE	PAGE
1-1.	8500A Options	1-2
1-2.	8500A Accessories	1-2
1-3.	8500A Controls, Indicators, and Connectors	2-3
2-2.	Error Codes	2-4
3-1.	Mnemonic Definitions	3-8
4-1.	Test Equipment	4-2
4-2.	Low Range DC Voltage Tests	4-4
4-3.	Autoranging	4-5
4-4.	Power Supply Verifications	4-7
4-5.	Linearity Checks	4-9
4-6.	Faulty Module Isolation	4-11

Model 8500A Digital Multimeter

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. This manual is composed of eight sections containing the information necessary to install, operate, and maintain the Fluke Model 8500A Digital Voltmeter. The 8500A employs modular construction allowing numerous possible configurations. Your manual employs a modular construction designed to furnish you with the most up-to-date information possible. Sections 1 through 5 and 8 contain information relating to the 8500A mainframe, which includes the modules necessary for DC Volts and DC Ratio measurements. Section 1 contains a list of available options and a table of specifications for the mainframe. Section 2 is operating instructions, Section 3 is theory of operation, Section 4 is maintenance, Section 5 contains parts lists, and Section 8 contains schematic diagrams. Section 6 contains information relating to the options contained in your instrument, including the specifications, operating instructions, theory of operation, maintenance, parts lists, and schematics. As the need arises to expand your 8500A system, the most up-to-date information for the options you order will be included with them. Section 7 is general information: lists of abbreviations, federal supply codes, Service Centers, and Sales Representatives.

1-3. DESCRIPTION

1-4. Mainframe

1-5. The Model 8500A Digital Voltmeter is a six and one-half digit instrument employing microprocessor control and a bus structure. All active components are contained in modules which plug into a mainframe motherboard. The modules function under direct control of a microprocessor-based controller, which addresses each module as a memory location, similar to a computer. Modular construction allows considerable versatility in option selection and reduction of downtime by simple replacement of a faulty module.

1-6. The use of microprocessor control gives rise to "virtual" modules through arithmetic processing. External referencing and offsets, normally requiring separate circuitry, are performed by taking separate measurements, storing the values in memory, and operating on them arithmetically. Digital filtering is accomplished by taking a number of samples synchronous to the line frequency at a rate equal to an even multiple of the line frequency and averaging them for each reading. Limits and high/low peak detection are available through an optional remote interface.

1-7. Fluke's patented recirculating remainder (R^2) technique of A/D conversion has been adapted to microprocessor control. This method provides fast, accurate, linear measurements with long-term stability.

1-8. Options

1-9. A list of options available for the 8500A is contained in Table 1-1. Two ac converter options, an ohms converter option, and a current shunts option complete the analog capability of the 8500A. Three possible remote interfaces may be used for systems operation, but only one may be installed at a time. If a remote interface is installed, the isolator option must replace the interconnect pcb to maintain guarding of the analog and high-quality busses. The three remote interface options allow maximum versatility in interfacing the 8500A to digital systems. A calibration memory option reduces downtime due to calibration requirements. Correction factors for each range, derived from a standard input, may be entered from the front panel. Further measurements are then automatically corrected with the calibration factor. Table 1-2 is a list of accessories available for the 8500A.

1-10. SPECIFICATIONS

1-11. Specifications relating to the 8500A mainframe (DC Volts and DC Ratio measurements) are presented in Table 1-3. Specifications for the instrument with options are presented with the information relating to each option in Section 6. The table of specifications has been divided into two parts: Accuracy, and Instrument Operating Characteristics. Accuracy specifications have been consolidated for ease in reference both by the user in divergent

applications and by the metrologist in performance determination. Detailed instrument operating characteristics have been provided to assure exact knowledge of the Model 8500A performance in every unique situation.

Table 1-1. 8500A Options

Option No.	Name	Notes
01	AC/DC Converter (Averaging)	1,3
02	Ohms Converter	
03	Current Shunts	3
04	Calibration Memory	
05	IEEE Standard 488-1975 Interface	2
06	Bit Serial Asynchronous Interface	2
07	Parallel Interface	2
08	Isolator	4
09	AC/DC Converter (True RMS)	1,3
17	Rear Input	

1) Options 01 and 09 cannot be installed simultaneously.
2) Only one of Options 05, 06, and 07 can be installed at any time.
3) For the AC portion of Option 03 to operate, either Option 01 or 09 must be installed.
4) Option 08 must be installed for remote operations.

Table 1-2. 8500A Accessories

Model or Part No.	Name
M04-205-600	Rack Ear Mounting Assembly
M00-260-610	18-inch Rack Slides
M00-280-610	24-inch Rack Slides
80F-5	High Voltage Probe
80F-15	High Voltage Probe
81RF	High Frequency Probe
82RF	High Frequency Probe
KDM1	Keyboard Display Module w/Cable
Y8001	IEEE Std. Cable, 1 Meter Length
Y8002	IEEE Std. Cable, 2 Meter Length
Y8003	IEEE Std. Cable, 4 Meter Length
MIS-7011K*	Extender Assembly
MIS-7190K*	Static Controller
MIS-7191K*	Test Module
MIS-7013K*	Bus Interconnect and Monitor

*For use during service or repair

Table 1-3. Specifications

ACCURACY

Note

The stated accuracies are valid under the following environmental conditions.

Temperature: 18°C to 28°C (Except 24 hour: 22°C to 24°C)

Humidity: ≤75%

Line Regulation: 90V to 110V, 103.5V to 126.5V, or 207V to 253V @ 45 to 66 Hz

DC Volts

Normal Resolution (Not in CAL Mode)					
Range	Full Scale	Resolution	Accuracy + (% of Input + Number of Digits)		
			24 Hours	90 Days	1 Year
100 mV	312 mV	1 uV	0.002 + 4	0.003 + 5	0.005 + 8
1 V	2.5 V	10 uV	0.001 + 1	0.002 + 1	0.004 + 1
10 V	20 V	100 uV	0.001 or 1*	0.001 + 1	0.002 + 1
100 V	160 V	1 mV	0.001 + 1	0.002 + 1	0.004 + 1
1000 V	1200 V	10 mV	0.001 + 1	0.002 + 1	0.004 + 1

*Whichever is greater.

Table 1-3. Specifications (Continued)

ACCURACY (Continued)

DC Volts (Continued)

High Resolution (In CAL Mode)

Range	Full Scale	Resolution	Accuracy ± (% of Input + Number of Digits)		
			24 Hours	90 Days	1 Year
1 V	2.5 V	1 uV	0.001 + 6	0.002 + 8	0.004 + 9
10 V	20 V	10 uV	0.001 or 6*	0.001 + 8	0.002 + 9
100 V	160 V	100 uV	0.001 + 6	0.002 + 8	0.004 + 9
1000 V	1200 V	1 mV	0.001 + 6	0.002 + 8	0.004 + 9

Whichever is less.

DC Ratio

Ext. Ref. Voltage	Accuracy
±20V to ±40V	±(A + B + 10 ppm)
$\pm V_{min.}$* to ±20V	$\pm\left(A + B + \frac{200\text{ ppm}}{\lvert V_{xref}\rvert}\right)$

A =10V dc Range Accuracy
B =Input Signal Function and Range Accuracy
V_{min} =Minimum Allowable External Reference Voltage
$|V_{xref}|$ =Absolute Value of External Reference Voltage

**The formula for determining V_{min} is included in Instrument Operating Characteristics*

Example Calculations for External Reference Accuracy:

1. Input = + 90.000V, Ext. Ref. Input = 30.000V (+ 15V to Ext. Ref. HI, −15V to Ext. Ref. LO)
   A = .001% + 1 Digit B = .001% + 1 Digit
   Ratio Accuracy = ±(A + B + 10 ppm) = ±(.001% + 1 Digit + .001% +1 Digit + .001% = ±(.003% +2 Digits)
   Reading may be between 3.0003 and 2.9997

2. Input = 1.20000V, Ext. Ref. Input = .12000 (V_{min} for 1V Range)
   A = .001% + 1 Digit, B = .001% + 1 Digit, $\frac{200\text{ ppm}}{V_{xref}} = \frac{.02\%}{.12} = .1667\%$

   Ratio Accuracy = ±.001% + 1 Digit + .001% +1 Digit + .1667%) = ±(.1687% + 2 Digits)
   Reading may be between .998313 and 1.001686.

INSTRUMENT OPERATING CHARACTERISTICS

DC Volts

TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)

Range	Temperature Coefficient
100 mV	± (3 ppm/reading + 0.5 digit)/°C
1V	±(3 ppm/reading +0.1 digit)/ °C
10 V	± (2 ppm/reading + 0.05 digit)/°C*
100 V	± (3 ppm/reading + 0.1 digit)/°C*
1000 V	± (3 ppm/reading + 0.05 digit)/°C*

For High Resolution Multiply Digits by 10.

INPUT IMPEDANCE

Range	Input Impedance
100 mV	>10,000 MΩ
1V	>10,000 MΩ
10 V	>10,000 MΩ
100 V	10 MΩ
1000 V	10 MΩ
Guard to Chassis	5.6 MΩ

INPUT BIAS CURRENT

	At time of Cal	30 Days (23°C ± 1°C)	Temperature Coefficient
Bias Current	<±5 pA	<±50 pA	±3 pA/°C

Table 1-3. Specifications (Continued)

INSTRUMENT OPERATING CHARACTERISTICS (Continued)

DC Volts (Continued)

RESPONSE TIME

Digitizing Time			Analog Settling Time Within Voltmeter		
Mode of Operation	Reading Rate	Digitizing Time	Filter Mode	Step Input to 0.01% of Change	Step Input to 0.001% of Change
Bench	50 Hz line 6-1/4 rdg/sec	162 ms	Bypassed Filter <100k Source Resistance (Remote)	2 ms	20 ms
	1-1/2 rdg/sec	642 ms			
	60 Hz line 7-1/2 rdg/sec	136 ms			
	1-7/8 rdg/sec	546 ms			
Remote	50 Hz 4 samples/rdg*	22 ms	Filter, Fast	40 ms	50 ms
	60 Hz 4 samples/rdg*	18 ms	Filter, Slow (Manual)	400 ms	500 ms

**Number of samples per reading is remotely programmable from 1 (2^0) to 131,072 (2^{17}) in 18 binary steps.*

ZERO STABILITY

Better than 5 μV for 90 days after a one hr. warm-up. Front Panel pushbutton auto zero is provided. The zero correction is stored in memory until power is interrupted or the 8500A is RESET. If calibration memory Option –04 is installed, the zero correction is retained.

OVERLOAD

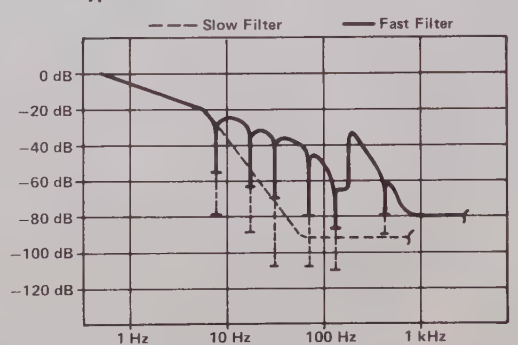
± 1200V DC to 60 Hz, or 1400V peak AC above 60 Hz may be applied continuously to any dc range without permanent damage. Maximum common mode rate of voltage rise is 1000V/μsec.

NOISE REJECTION

Normal Mode						Common Mode	
Line/Filter Frequency	4 Samples/ Rdg*	7-1/2 rdg/s	6-1/4 rdg/s	1-7/8 rdg/s	1-1/2 rdg/s	True	Effective
50 Hz Fast Filter	60 dB	N/A	70 dB	N/A	75 dB	100 dB at 60 Hz for 1 KΩ unbalance	Sum of Common Mode Rejection and Normal Mode Rejection
50 Hz Slow Filter	85 dB	N/A	90 dB	N/A	95 dB		
60 Hz Fast Filter	60 dB	70 dB	N/A	75 dB	N/A		
60 Hz Slow Filter	90 dB	95 dB	N/A	100 dB	N/A		

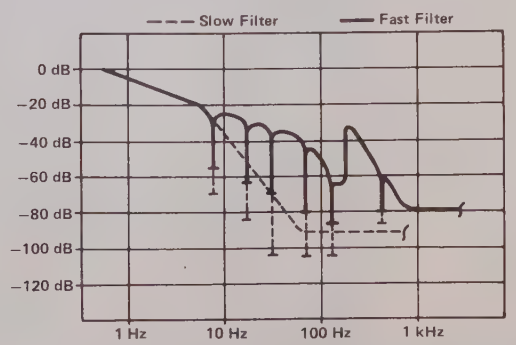
**Remotely selected*

1-7/8 Readings/Second
Typical Performance with 60 Hz Line



Cusps shown are at multiples of 60 Hz line frequency

1-1/2 Readings/Second
Typical Performance with 50 Hz Line



Cusps shown are at multiples of 50 Hz line frequency

Table 1-3. Specifications (Concluded)

INSTRUMENT OPERATING CHARACTERISTICS (Continued)

DC Ratio

INPUT IMPEDANCE

Ext Ref HI or LO X 10,000 MΩ relative to Ohms Guard* or Sense LO

SOURCE IMPEDANCE

Resistive Unbalance (Ext Ref HI to LO) <4 kΩ

Total Resistance Sense LO from either HI or LO <20 kΩ

BIAS CURRENT

Ext Ref HI or LO relative to Ohms Guard* or Sense LO <5 nA

OVERLOAD (Ext Ref HI or LO)

±180 volts peak , 127V rms (relative to Ohms Guard* or Sense LO) X (360V peak HI to LO)

Ohms Guard available through rear input option

NOISE REJECTION

Normal Mode	Common Mode, All Inputs Driven
Sense Input—Same as dc volts	**Sense Input**—Same as dc volts
Ext Ref Input—dc, line frequency and 2x line frequency >100 dB	**Ext Ref Input**—Line frequency and 2x line frequency, 75 dB

RESPONSE TIME

Settling Time

Sense Input Fast Filter < 50 ms to 0.001% of change
Sense Input Slow Filter < 500 ms to 0.001% of change

Digitizing Time

NOTE

The Sense Input is measured prior to measuring Ext Ref HI and LO.

Ext Ref Input—Each input HI and LO

90 ms at 60 Hz line frequency
107 ms at 50 Hz line frequency

Ext Ref Calibration—12 ms

Sense Input			
Mode of Operation	Line Volt	Approx. Rdg. Rate	Digitizing Time
Bench	60 Hz	4½ rdg/s	136 ms
		1½ rdg/s	536 ms
	50 Hz	3½ rdg/s	162 ms
		1¼ rdg/s	642 ms
Remote	60 Hz	4 samples/rdg	18 ms
	50 Hz	4 samples/rdg	22 ms

EXT REF VOLTAGE RANGE

Maximum Ext Ref Voltage = ±40V between Ext Ref HI and LO terminals, providing neither terminal is greater than ±20V relative to the Sense LO or Ohms Guard terminals.

Minimum Ext Ref Voltage = ±0.0001V, or $\frac{V_{input}}{\text{Maximum Display within Range}}$ (whichever is greater)
(See Table Below)

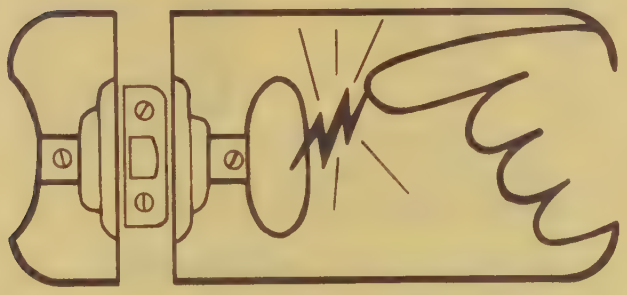
MAXIMUM DISPLAY—(Ratio/Scaling)

AC & DC VOLTS		AC & DC CURRENT		OHMS	
Range	Maximum Display (V/V)	Range	Maximum Display (A/V)	Range	Maximum Display (Ω/V)
100 mV	$\pm 999.999 \times 10^{-3}$	100 uA	$\pm 999.999 \times 10^{-6}$	10 Ω	±99.9999
1 V	±9.9999	1 mA	$\pm 9.99999 \times 10^{-3}$	100 Ω	±999.999
10 V	±99.9999	10 mA	$\pm 99.9999 \times 10^{-3}$	1 kΩ	$\pm 9.99999 \times 10^{3}$
100 V	±999.999	100 mA	$\pm 999.999 \times 10^{-3}$	10 kΩ	$\pm 99.9999 \times 10^{3}$
1000 V	±1279.99	1 A	±1.2799	100 kΩ	$\pm 999.999 \times 10^{3}$
				1 MΩ	$\pm 9.99999 \times 10^{6}$
				10 MΩ	$\pm 99.9999 \times 10^{6}$
				100 MΩ	$\pm 999.999 \times 10^{6}$

static awareness

A Message From

John Fluke Mfg. Co., Inc.

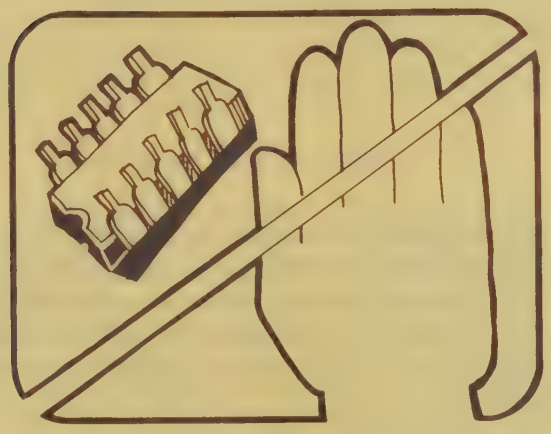


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

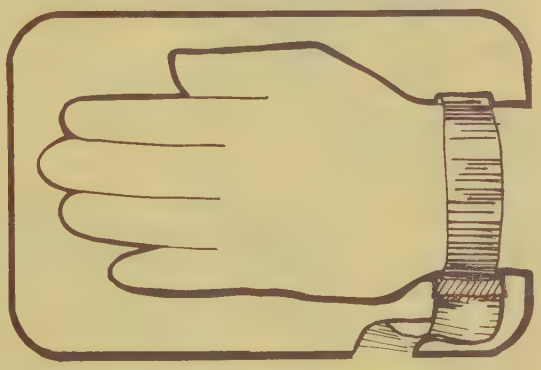
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗".

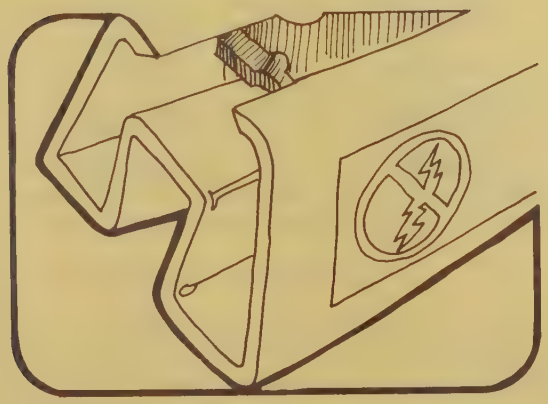
The following practices should be followed to minimize damage to S.S. devices.



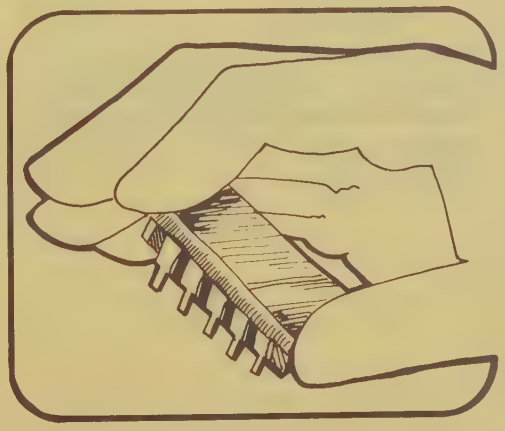
1. MINIMIZE HANDLING



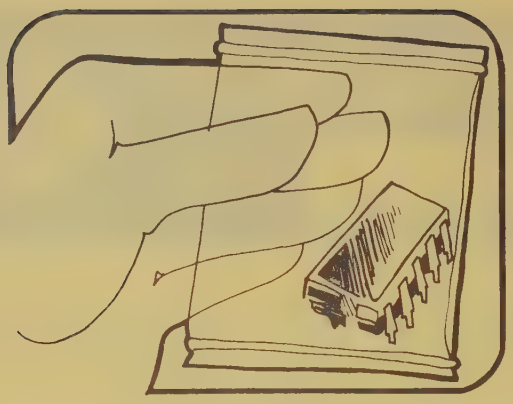
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



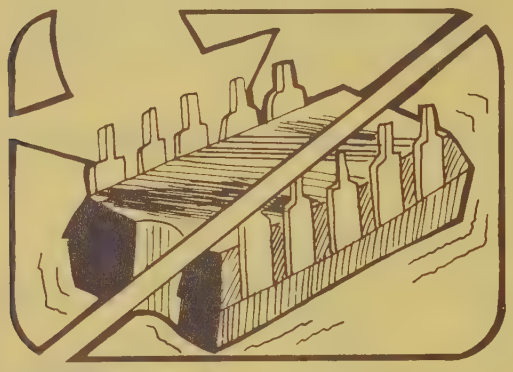
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



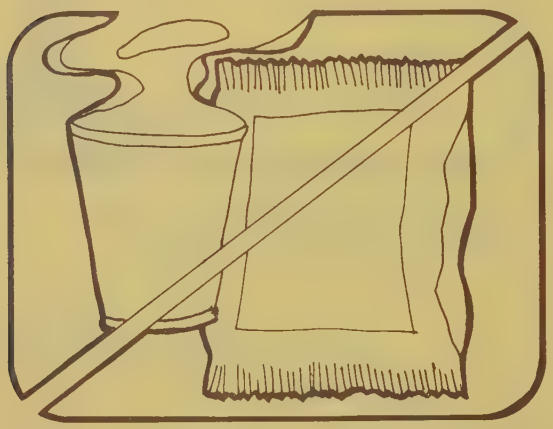
4. HANDLE S.S. DEVICES BY THE BODY



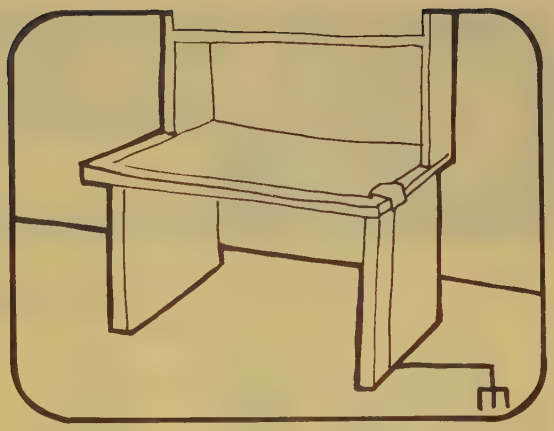
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYRAFOAM IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the Model 8500A Digital Voltmeter. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc.; P. O. Box 43210; Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of Sales Representatives is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 8500A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included with the shipping container.

2-5. If reshipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INSTALLATION

2-7. Non-marring feet and a tilt-down bail are installed on the instrument for field or bench use. A rack-mounting kit and rack slides are available for use with standard 19-inch equipment racks. Information regarding installation of rack-mounting accessories is contained in Section 6.

2-8. Input Power Requirements

2-9. The 8500A operates from either 115V ac ± 10% or 230V ac ± 10%, 50 or 60 Hz (103.5 to 126.5V ac, or 207 to 253V ac, 45 to 66 Hz). The line voltage that the 8500A is operated from must be within the specified tolerance. A binding post on the rear panel has been provided to assure a proper earth ground connection. Section 4 contains instructions for switching the power supply from accepting 115V ac to 230V ac or vice versa. Operation at 50 Hz is the same as at 60 Hz except for slower response times.

CAUTION

Unless the chassis of the 8500A is properly grounded, the possibility of electrical shock may occur when measuring high ac voltage with the leads reversed (Input HI grounded). The ground connection has been provided in the three-prong connector.

2-10. Fuses

2-11. The line fuse is located on the rear panel near the heatsink. Use a ½ A MDL (slow-blow) fuse for replacement. The current protection fuse is located in the lower right-hand corner of the front panel. Use an AGC 1½ A replacement fuse.

2-12. OPERATING FEATURES

2-13. The location and function of all 8500A controls, indicators, and connectors are shown in Figure 2-1 and described in Table 2-1.

2-14. OPERATING NOTES

2-15. General

2-16. Upon applying power to the 8500A, the display will read "HI" and then the option configuration (Cxxxxx, where x is the installed option number). During this period a function and range may be selected; if not, the instrument will place itself in the DC Volts function, 1000V range. All front panel switches except the power switch and the CAL switch are momentary contact switches. If a switch is held in continuously, it will be "read" only one time (automatic debouncing). For rated measurement accuracy, the 8500A should be allowed to warm up for one hour.

2-17. The display consists of five and one-half digits with an exponent to give readings in engineering notation. Decimal placement and reading and exponent polarity are automatically provided. If desired the exponent may be replaced by an extra digit of resolution (refer to the explanation for the CAL mode switch later in this section).

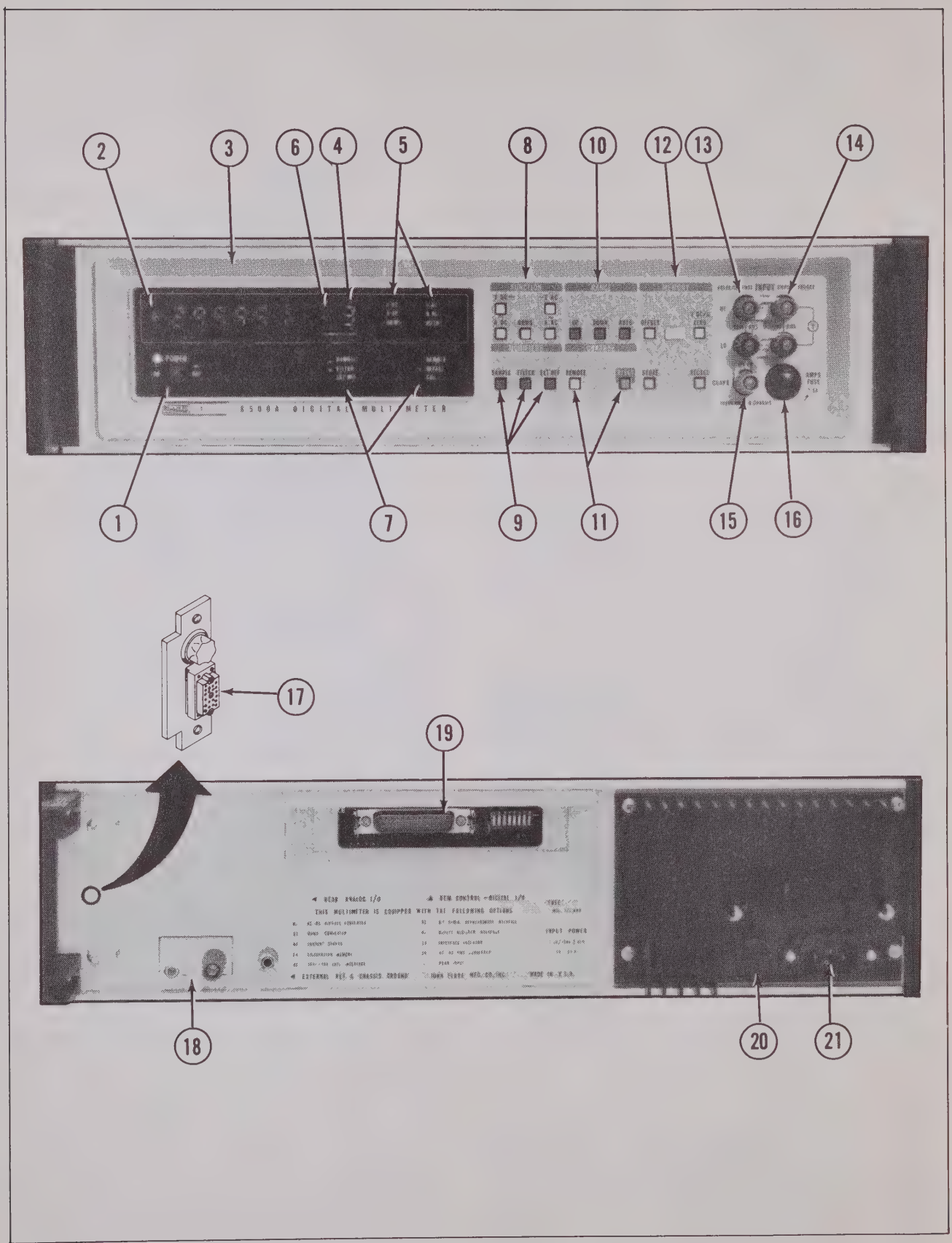


Figure 2-1. 8500A Controls, Indicators, and Connectors

Table 2-1. 8500A Controls, Indicators, and Connectors

REF. NO.	NAME	FUNCTION
1.	Power Switch	Push on/Push off for line power
2.	Polarity Display	Displays polarity of readings when appropriate
3.	Digit Display	Displays value of reading with properly positioned decimal
4.	Exponent Display	Displays exponent for engineering notation
5.	Range and Function Indicators	LEDs illuminate to indicate function selected and whether or not in autorange
6.	Modifier Indicators	LEDs illuminate to indicate modifiers selected, sample indicator blinks at reading rate selected
7.	Control and Memory Indicators	LEDs illuminate to indicate status of remote, offset, and CAL modifiers
8.	Function Switches	Selects function—DC Volts, AC Volts, DC and AC Volts, DC Current, AC Current, and Ohms. Optional modules must be installed for other than DC volts. Error 9 will be displayed if a function is selected for which the module is not installed
9.	Modifier Switches	Selects samples/rdg rate, filter (fast or slow) and external reference
10.	Range Switches	UP and DOWN change the range one range at a time, AUTO selects or disables autoranging
11.	Control Switches	REMOTE toggles control from front panel to remote-selecting remote disables all front panel switches except POWER and REMOTE. RESET initiates a master program restart (to the beginning)
12.	Memory Switches	OFFSET, VDC/Ω ZERO, STORE, and CAL are used to place values into memory for computations. ZERO and CAL factors are applied automatically. OFFSET function must be selected separately from entering a value into memory. CAL may be used to obtain an extra digit of resolution in all but the lowest range. RECALL is used to display a previously entered CAL, OFFSET, or DC ZERO factor.
13.	Input VOLTS/Ω Sense Terminals	HI and LO connections for DC and AC voltages and Ohms measurements
14.	Input AMPS/Ω Source Terminals	HI and LO connections for Current and Ohms measurements
15.	Guard Terminal	For guarded measurements (should always be connected)
16.	Current Fuse	Use a 1½ Amp Fast Blow Fuse
17.	Parallel Rear Analog Input Terminals	Optional terminals having same functions as those on front panel with the addition of an Ohms guard terminal
18.	Ext Ref Terminals	Input for external referencing
19.	Interface Connector and Switches	Connector and address switches installed on a remote interface module accessible through the rear panel
20.	Line Fuse	Use an MDL ½ (slo-blow)
21.	AC Line Voltage Connector	Three-prong connector accepting line cord with ground wire

2-18. Function Selection

2-19. A function may be selected simply by depressing the switch for the desired function. DC volts is standard with the 8500A mainframe. For ac volts, dc or ac current, and ohms functions, optional modules must be installed in the 8500A. Operations peculiar to each function will be explained in Section 6. If a function is selected for which the option is not installed, Error 9 will be displayed.

2-20. Error Codes

2-21. The Front Panel display and the optional interface output will indicate an error by displaying an Error Code. For operator convenience, a pull out tab, under the instrument on the right side, contains a set of condensed operating instructions which lists the errors associated with the various codes. The codes and the errors causing them are listed in Table 2-2. If the CAL mode is selected, Error Codes will not be displayed. Any function may be selected, and if the module is not installed, random readings will be displayed.

2-22. DC Voltage Measurement

2-23. The Model 8500A mainframe measures dc volts in five ranges (100 mV to 1000V). Resolutions from 1μV on the lowest range to 1 mV on the highest range are available. Overrange or full-scale capabilities progress in an octal relationship from 312 mV on the lowest range to 1200V on the highest range. All ranges are completely protected from overload conditions as specified in Section 1. Input impedance is greater than 10,000 megohms in the 100 mV, 1V, 10V ranges; 10 megohms in the 100V and 1000V ranges. DC voltage accuracies are specified in Section 1.

2-24. Input Terminals

2-25. For dc voltage measurements, the Input HI terminals may be left strapped together and the Input LO terminals may be strapped together. For most measurements it is sufficient to strap the guard terminal to the Input LO terminal. Shorting links have been provided for making these connections. A more complete description of the use of the guard terminal is included later in this section. Do not ground the Input HI terminal and drive the LO terminal as the guard bleeder resistor will reduce the input impedance to 5.6 MΩ.

CAUTION

The guard terminal should not be left disconnected as common mode voltages may exceed the LO to guard voltage rating, possibly resulting in damage to the instrument.

2-26. Range Selection

2-27. Autoranging may be selected by depressing the AUTO switch. When autoranging is selected, the AUTO LED in the display will light. Depressing the AUTO switch again will select manual ranging without changing the range. Depressing the UP or DOWN switches will also select manual ranging while changing the range one at a time in the desired direction. When the voltage at the input terminals exceeds the full-scale value for a range, the digit display will flash HHHHHH on and off at the sample rate unless the cal mode has been selected. When a valid function switch is depressed, the instrument automatically shifts to autoranging.

Table 2-2. Error Codes

CODE	FAULT
Error	System error — if the error message appears prior to the introductory messages at power initialization or reset, the problem is with the calibration memory module.
Error 0	VDC/Ω Zero Error — either a VDC/Ω Zero was attempted in a range other than 100mV or 10Ω, or an overrange value was entered.
Error 1	Offset error — either down ranging was attempted past the range of the offset, the offset was recalled in a different function than was stored, or it was toggled into offset in a function where an offset value was not stored.
Error 2	Filter Module error — the Module is faulty or not installed.
Error 3	DC Signal Conditioner error — the Module is faulty or not installed.
Error 4	Ohms or Current error — excessive voltage applied to the selected module, shorting links not properly connected, or the selected module is faulty.
Error 5	R^2 A/D error — the recircuitating remainder analog to digital converter module is faulty or not installed.
Error 6	Numeric display overflow error.
Error 7	External reference error — the magnitude of one of the ext ref inputs is greater than 20V dc.
Error 8	Controller error — the module is faulty or not installed.
Error 9	Function Selection error — the function module selected, other than dc volts, is faulty or not installed.

2-28. Modifier Selection

2-29. SAMPLE RATE

2-30. Two sample rates are available from the front panel: 128 samples/reading and 32 samples/reading. The resulting reading rates are approximately 2 readings/second and 8 readings/second respectively for a 60 Hz line frequency (6 rdgs./sec. and 1½ rdgs./sec. for 50 Hz operation). Samples are taken syncronous to the line frequency so the greatest line noise rejection is at the 2 readings/second rate. (The larger the number of samples averaged the greater the line noise rejection.) The SAMPLE indicator LED flashes at the rate the readings are being taken.

2-31. FILTERING

2-32. The front panel FILTER switch selects either a fast filter or a slow filter. Fast and slow refer to the settling times required for each filter. When the FILTER LED is illuminated, the slow filter has been selected. The slow filter has a faster roll-off below 60 Hz and provides better normal mode noise rejection at 60 Hz than the fast filter. The fast filter discriminates against higher frequency and harmonically-related line noise and should be used when faster settling times for stepped input functions are required and where noise is not a problem.

2-33. EXTERNAL REFERENCE

2-34. The external reference feature may be used to divide an input to the input terminals (any function) by the value of dc voltage applied to the External Reference input terminals located on the rear panel.

$$\text{Reading} = \frac{\text{Input}}{\text{dc Ext. Ref. Input}}$$

This is a true ratio measurement arrived at by measuring the values at the two sets of input terminals. Then the reading is computed by the microprocessor in the Controller Module. The External Reference terminals will only accept a dc voltage. The maximum value which may be applied is ± 20V to either terminal with respect to the SENSE LO terminal or ohms guard [on the optional rear panel input terminals (Option –17)] A connection must be made from Sense LO to either External Reference HI or LO having a total resistance of less than 20 kΩ. So a maximum of 40V may be applied between the external reference terminals. The minimum voltage which may be applied is ±100 μV or the absolute value of the input to the Volt/Ω terminals divided by the maximum display within the input range when in the external reference mode, whichever is greater. A table of the maximum displays for each range when in the external reference mode is included in the specifications in Section 1.

$$V_{min} = \frac{|\text{Vinput}|}{\text{Maximum Display Within Range}}$$

Example: Voltage applied to the Volt/Ωterminals = –8.0000 V

Maximum Display Within 10V range (ext ref mode) = ±99.9999

$$V_{min} = \frac{8.0000\text{V}}{99.9999} = .0800001\text{ V}$$

2-35. External reference is selected by depressing the EXT REF switch. If the switch is held in, the display will read out the value of dc voltage applied to the External Reference terminals (this value is displayed only when selecting the external reference mode). The external reference mode is turned off by depressing the EXT REF switch again.

2-36. Two examples of accuracy determination have been included in the specifications in Section 1. These examples are of most use to a metrologist in that known inputs were used and allowable deviations were the results. The following is an example of determining a pure percentage (without ± digits) to be applied to unknown inputs.

Measured Volt/Ω input = 9.0000V

Measured Ext. Ref. input = 2.0000V

$$\text{Accuracy} = \pm\left(A + B + \frac{200\text{ ppm}}{|\text{Vxref}|}\right)$$

where A = 10V dc range accuracy
B = Input signal function and range accuracy
|Vxref| = Absolute value of external reference input

A = .001% + 1 digit

$\frac{200\text{ ppm}}{\text{Vxref}} = \frac{.02\%}{2}$

B = .001% + 1 digit

A & B = .002% + 2 digits

$\frac{200\text{ ppm}}{|\text{Vxref}|} = .01\%$

Accuracy = .012% + 2 digits

Translating digits to percentage:

Ratio Reading = 4.5000

Same number of digits behind decimal as in maximum range reading

2 digits is .0044% of 4.5000 $\left(4.5\sqrt{\frac{.000044}{.0002}}\right)$

Accuracy expressed as a percentage = ± .0164%

2.37. Safety Warning Indications

2-38. In the external reference and offset modes when an input at the terminals exceeds 40 volts, the exponent figure flashes the symbol "H" to warn the operator that a more dangerous voltage is present at the input than is displayed by the 8500A. If the CAL switch is in the Cal mode position (CAL indicator illuminated) no indication of warning is given. An example would be when the external reference input is equal to 10 volts and the input at the terminals is 50 volts. This gives a reading of 5 volts which does not show the operator that a potentially dangerous voltage is present on the input terminals. The flashing indicators are a warning only. They have no effect on the operation of the instrument.

2-39. Control

2-40. Depressing the REMOTE switch places the instrument in remote control. When in remote, only the REMOTE switch and the POWER switch will have any effect on the operation of the instrument. Depressing the REMOTE switch a second time or briefly removing the power will return the instrument to front panel control. When placed in remote, the operation of the instrument will cease (except the display) until new commands are received through an optional remote interface.

2-41. The RESET switch is used to start the main program over again. The display will read out "HI" and then the option configuration. If a function or range is not selected during this period, the instrument will place itself in the DC Volts function, 1000V range.

2-42. Memory

2-43. OFFSET

2-44. The OFFSET switch is used to select or disable the offset mode. In the offset mode, whatever offset value has been entered into memory will be automatically subtracted from subsequent readings. To enter an offset value into memory, first apply that input value (any function) to the Volt/Ω input terminals. Depress the STORE switch. A "?" will be displayed. Then depress the OFFSET switch. The value applied to the input terminals is now entered in memory. The instrument may already be in the offset mode when entering a value into memory. If not, entering a value into memory will not place the 8500A into the offset mode. The offset function cannot be selected in a range lower than the one in which an offset value was placed in memory.

2-45. VDC/ΩZERO

2-46. Zeroing is performed by the 8500A as an automatic operation. Separate zero values may be stored for VDC and ohms functions (provided the ohms option module is installed). Zero values or correction factors are entered by depressing the STORE switch, then the VDC/Ω ZERO switch. The instrument must be in the lowest range (100 mV or 10 Ω). Any internal drift may be corrected for with the zero functon by placing a good quality short on the input terminals (HI to LO) and depressing the STORE switch, then the VDC/Ω ZERO switch.

2-47. CALIBRATION MODE

2-48. The calibration mode may be used to perform two functions: adding an extra digit of resolution (except in the lowest range) and entering calibration factors for each function and range (the optional calibration memory Option –04 must be installed). The CAL switch is accessible through a hole in the front panel. A small plastic cover pops out and hinges down. Using a small screwdriver or similar tool, push the slide switch down to enter the Cal mode. The CAL LED will light to indicate that the instrument is in the Cal mode. The exponent display is used for the extra digit of resolution so the exponents are lost (except the exponent polarity). Placing the instrument in the Cal mode disables the Error Code function. Any function may be selected and if the option is not installed, random readings will be displayed. If the Cal memory option is installed, inadvertently depressing the STORE switch will erase the calibration factor for whichever function and range the instrument was in. Refer to Section 6 for further instructions about the Calibration Memory option.

2-49. STORE and RECALL

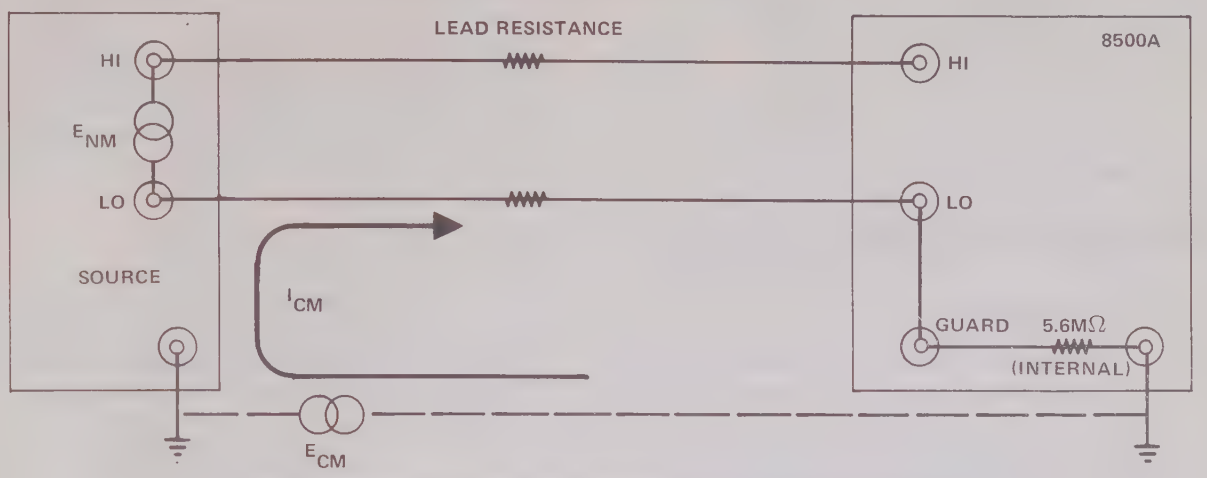
2-50. The STORE switch is used to enter values into memory (Offset, CAL, VDC/Ω Zero) as previously explained. Recall may be used to display a stored value. First depress the RECALL switch, then the desired value switch (OFFSET or VDC/Ω ZERO). Ohms zero values cannot be recalled. The value will be displayed as long as the switch is held depressed. The value displayed will be presented in the resolution of the range the instrument was in when the RECALL switch was depressed.

2-51. Guarding

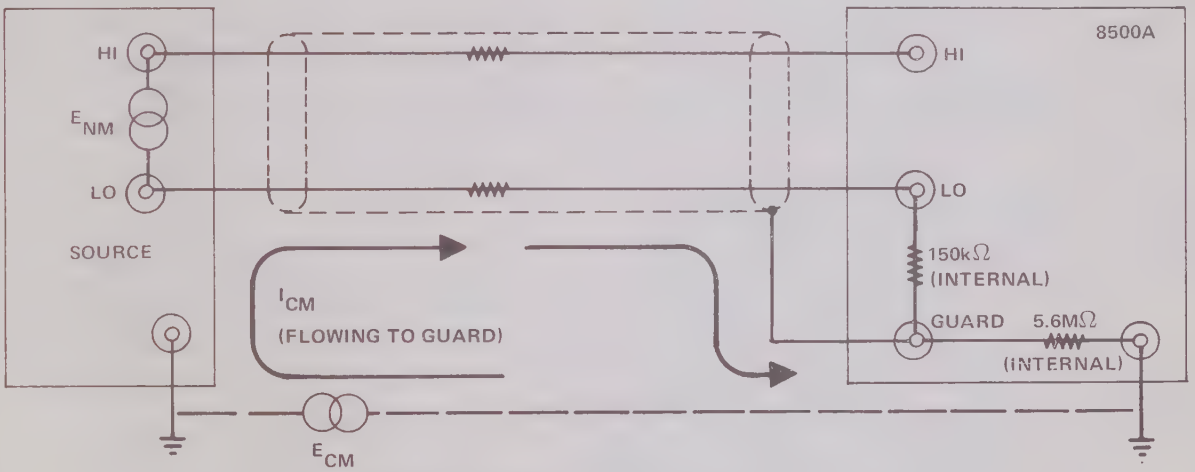
2-52. Common mode voltages are differences in potential that exist between two points that are grounded or common due to voltage drops along the ground wires or to currents induced into them. Normal mode voltages are the voltages and noise of a source to be measured. Common mode voltages may induce current flow through test leads and possibly through the internal impedance of the DVM, producing significant errors. The use of a floating, guarded voltmeter will minimize common mode errors but only if the input and guard connections are made properly. Figure 2-2 shows possible ways of connecting the 8500A to minimize common mode errors. There are two important considerations in using the guard connection. Connect the guard terminal for minimum difference of potential between the guard and input LO terminals. The input LO to guard maximum voltage rating of the 8500A is 100V. Connect the guard to minimize common mode currents flowing through any resistance which helps determine the voltage being measured.

CAUTION

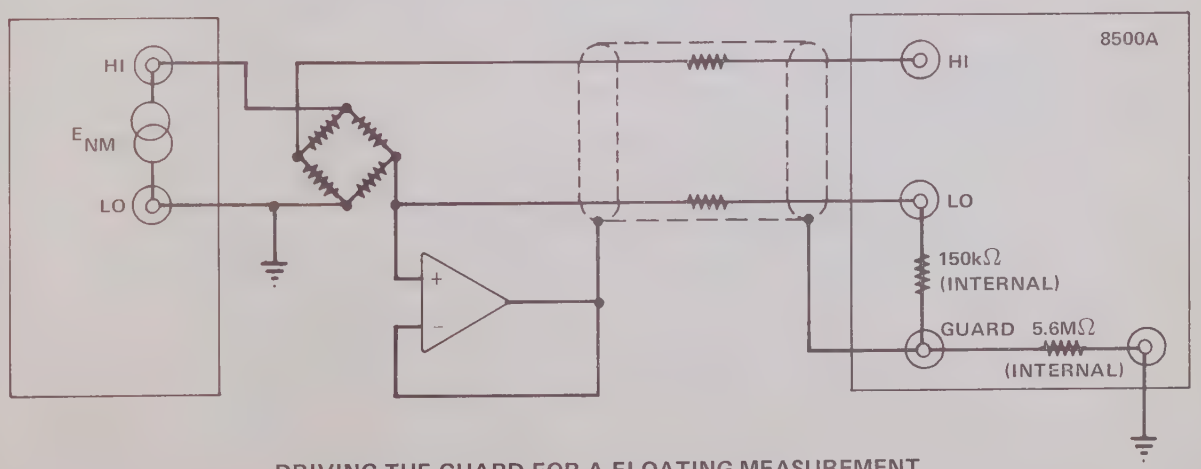
The guard terminal should always be connected either to the input LO terminal or to a point in the source circuit to be measured. With the guard terminal left open, common mode voltages may exceed the input LO to guard breakdown voltage, possibly damaging the instrument.



FOR NONCRITICAL MEASUREMENTS – E_{CM} ERROR PRESENT



E_{CM} ERROR MINIMIZED – I_{CM} FLOWS THROUGH SHIELD INSTEAD OF THROUGH TEST LEADS



DRIVING THE GUARD FOR A FLOATING MEASUREMENT WHICH MAY BE LOADED BY DIRECT CONNECTION OF THE GUARD

Figure 2-2. Guard Connections

2-53. The following conditions are examples of situations in which guarding should be employed:

a. When long signal leads are used.

b. When the signal source impedance is high.

c. When making floating measurements.

d. When making measurements in the presence of high-level noise, such as power line radiation.

2-54. Thermal EMFs

2-55. When making low level, high resolution measurements, the possibility for error due to thermal EMFs should be considered. Generally, thermal EMFs are voltages produced by temperature differences between contacts of two dissimilar metals or by temperature gradients along a length of a material. In some circumstances differences in potential of several microvolts may exist. Input terminals of the 8500A are gold-plated. The use of low EMF, shielded cables with gold-plated spade lugs will minimize thermal EMF errors.

2-56. Systems Use of the 8500A

2-57. Remote interface options are available which will enable the user to interface the 8500A to a large variety of digital systems. All operating and programming instructions relating to remote operation are included in Section 6.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation for the 8500A mainframe, which includes the modules necessary for DC Volts and DC Ratio measurements. Block Diagram Description gives an overview of the operation of the modules and an explanation of the bus structure. Circuit Analysis gives a more detailed description of the circuitry. Optional modules are described in Sect. 6.

3-3. BLOCK DIAGRAM DESCRIPTION

3-4. Bus Structure

3-5. The 8500A is constructed with a bus architecture similar to a computer. Figure 3-1 is an overall block diagram of the instrument with optional modules drawn in dashed lines. Figure 3-2 is a block diagram illustrating signal flow. A microprocessor-based controller module controls information flow on the three buses. The controller sets up each of the analog modules for a measurement by addressing the modules as memory locations. An unguarded digital interbus is used to connect the controller to the front panel and to digital option modules such as the calibration memory and a remote I/O (input/output) interface.

3-6. The unguarded digital interbus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, seven real time (RT) lines, three handshake (INT-interrupt, ACK-acknowledge, INA-interrupt acknowledge) lines, and power supply lines.

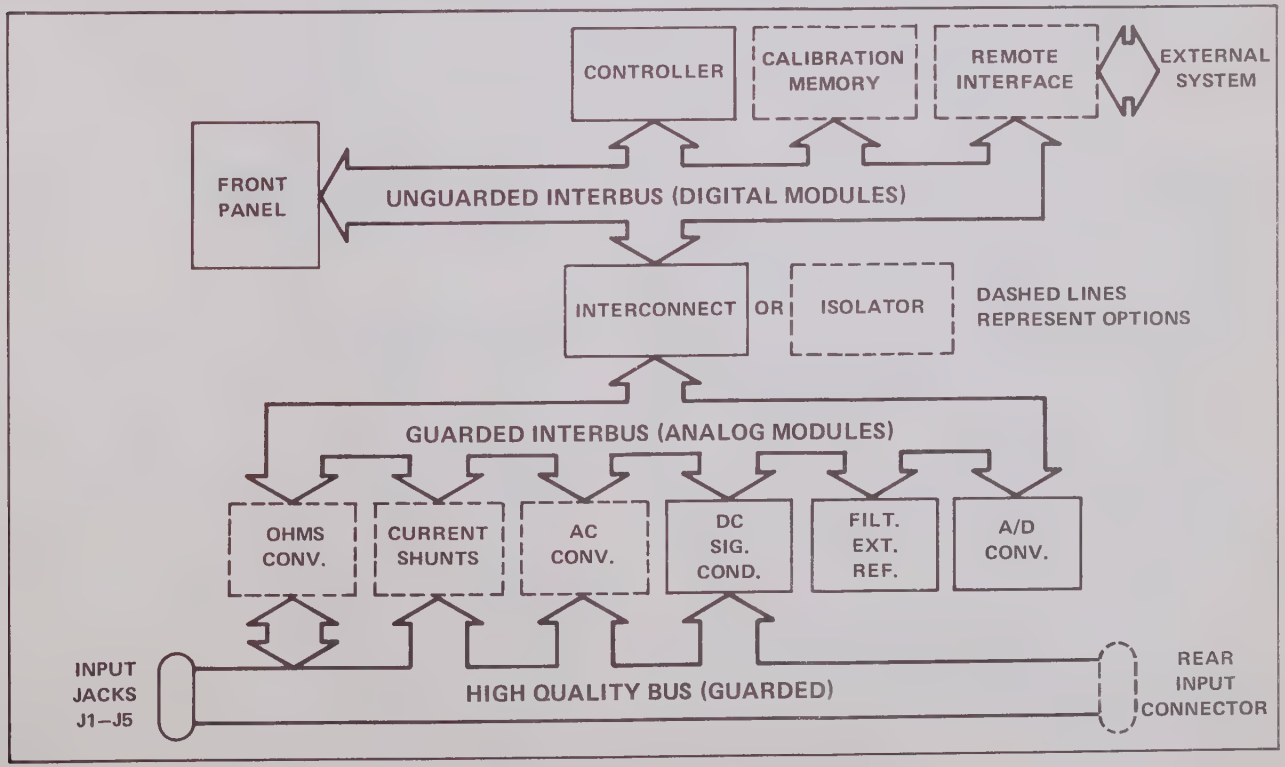


Figure 3-1. 8500A Block Diagram

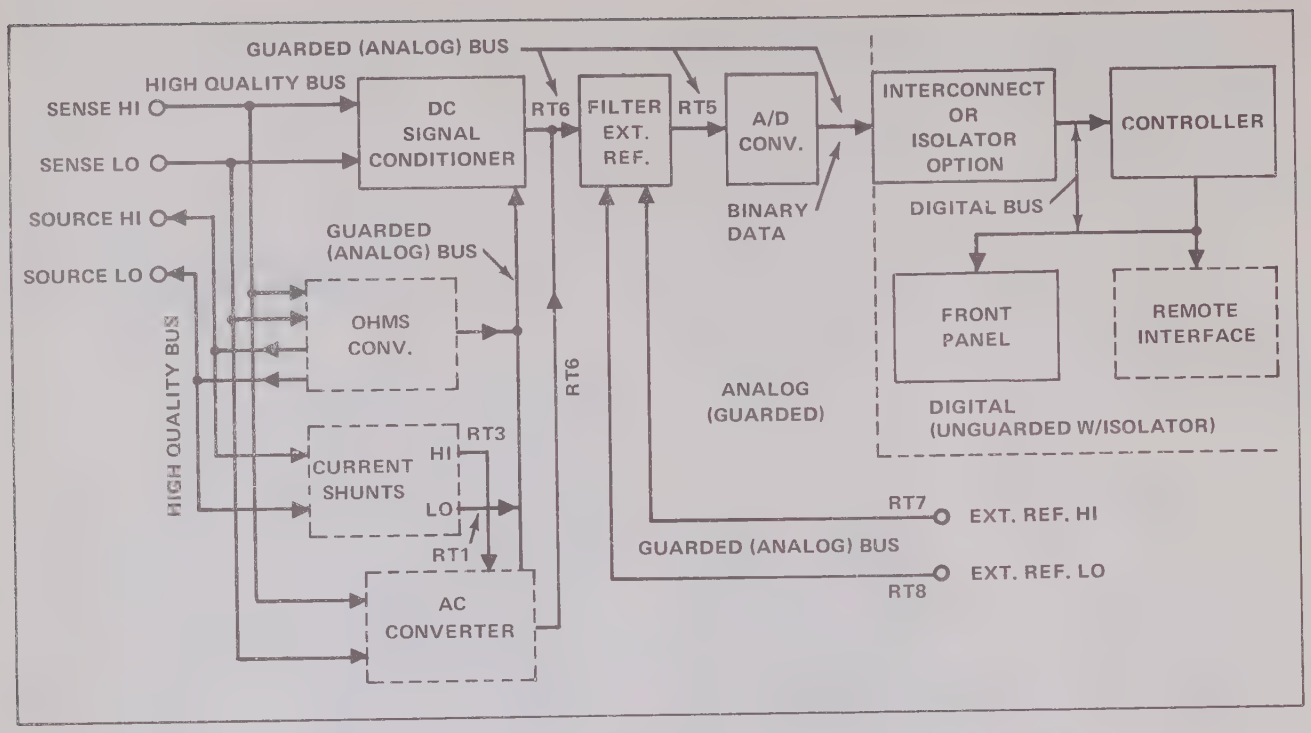


Figure 3-2. 8500A Analog Signal Flow

3-7. A guarded bus connects the controller to the analog modules through an interconnect pcb or through an optional isolator module (must replace the interconnect pcb if an optional remote interface is installed). The guarded bus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, nine real time (RT) lines, one handshake (ACK) line, and power supply lines.

3-8. The address, handshake, and data lines of the two buses serve the same functions. The real time and power supply lines may have differing functions. For example, the RT lines in the unguarded bus are unused except for RT5 which is the line frequency reference. The RT lines in the guarded bus form an analog bus which carry all the conditioned and converted analog signals between the analog modules. The external reference input lines are part of the analog bus (RT7 and RT8). Logic supply lines (Vcc and Vss) will be different in the two busses if an isolator option is installed. In the guarded bus, Vcc and Vss are always −15V and −20V with respect to analog common. In the unguarded bus with an interconnect pcb installed Vcc and Vss are diode coupled to the guarded bus. But with the isolator option installed, Vcc and Vss are isolated from analog common.

3-9. The third bus is the high quality bus (guarded) consisting of lines connecting the analog input terminals (Input HI and LO, source HI and LO, Guard, Ohms Guard) to the signal conditioning and converting modules. Ohms Guard is available only through the optional Rear Input (−17) connector.

3-10. Controller

3-11. Under the direction of the software program, the controller addresses and sets up each of the modules necessary to perform a function. Two types of addresses are used: direct and indirect. An indirect address requires a previous direct address to set up the indirect address response logic. Data transfers are accomplished with a handshake between the address (IC) lines and the acknowledge (ACK) line. When the controller addresses a module, it places data on the data (ID) lines or receives data from the addressed module. The addressed module must respond with an ACK signal signifying that it is receiving or sending data.

3-12. The controller directs the R^2 A/D converter in taking a sample and receives the sample data from the converter. Range and function information is stored by the controller for application to the data. Using the arithmetic capability of the microprocessor, the software processes the data to arrive at a binary 2's complement number which represents the polarity and value of the measurement. This number is made available to an optional remote interface either as is or after further processing to ASCII code. The number is further processed by the controller for application to the front panel display in a seven segment LED format.

3-13. The software program consists of two parallel processes. A background process (Figure 3-3) is responsible for interrupt driven activities such as updating the display digits and directing the A/D converter in taking a sample.

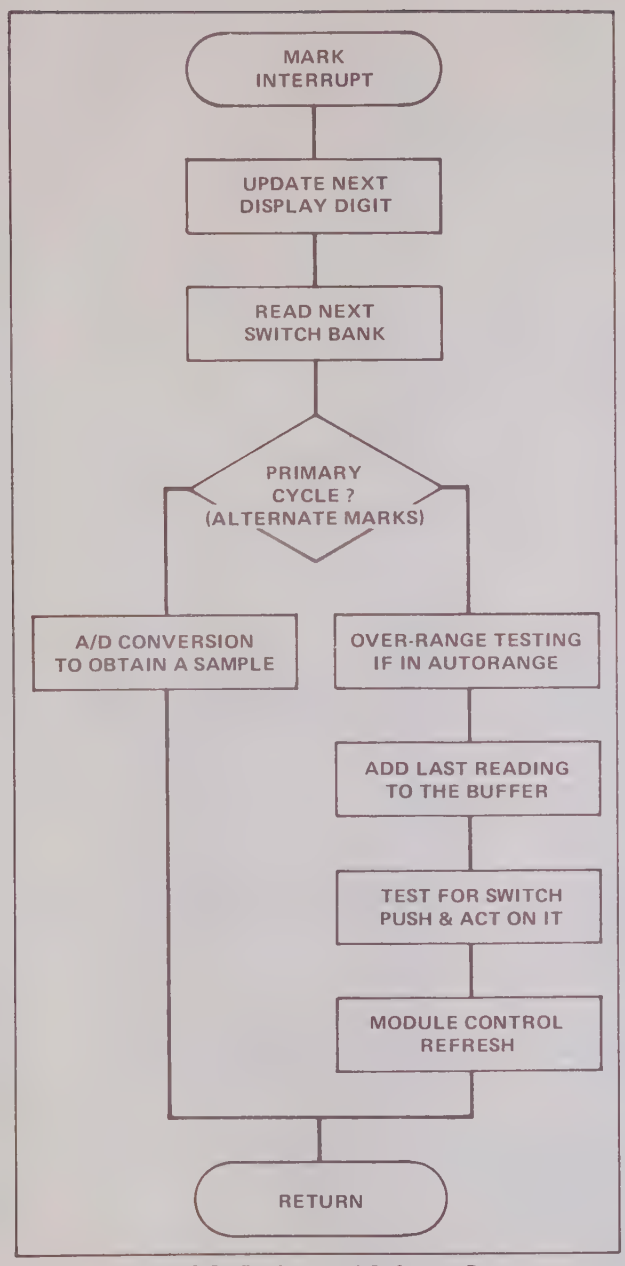

MARK INTERRUPT
UPDATE NEXT DISPLAY DIGIT
READ NEXT SWITCH BANK
PRIMARY CYCLE ? (ALTERNATE MARKS)
A/D CONVERSION TO OBTAIN A SAMPLE
OVER-RANGE TESTING IF IN AUTORANGE
ADD LAST READING TO THE BUFFER
TEST FOR SWITCH PUSH & ACT ON IT
MODULE CONTROL REFRESH
RETURN

Figure 3-3. Background Software Process

The foreground process (Figure 3-4) is responsible for the measurement cycle including accumulating data from the background process and performing required calculations.

3-14. The controller is structured around the Intel 8080 microprocessor. Figure 3-5 is a block diagram of the controller module. Hardware control functions have been minimized by careful software design. Sequences of events are timed from two sources. Basic operations of the microprocessor are run from a 1.7 MHz clock. The other source is generated by shaped line frequency pulses, which are applied to a phase-locked loop. The phase-locked loop multiplies the line frequency by eight. This signal is used to generate mark interrupts which time the background process.

3-15. Software for the 8500A is stored in four ROMs (read only memory). Four RAMs (random access memory) are used for temporary storage of data by the microprocessor. Data lines (DBO-DB7) are used for bidirectional data flow. Address lines (A0-A15) determine the source or storage location of data. Since other modules of the 8500A system are addressed as memory locations, address and data I/O controls are used for access to the external bus structure.

3-16. Interrupts are used to divert the microprocessor from the main program to service other routines. Interrupts are synchronized to an appropriate time in the microprocessor cycle through interrupt control, where assigned priorities vector module identity data onto the data bus. Module identity data words direct the microprocessor to the memory location containing the next instruction. Two interrupts are internally generated: ACK INT and MARK INT (priorities one and six respectively). ACK INT is generated when an acknowledge signal is not returned. MARK INT is used to synchronize A/D samples and display digit updates to the line frequency.

3-17. An interrupt may be externally requested by pulling the INT line low. When the microprocessor is ready to accept the interrupt, the interrupt acknowledge (INA) signal is generated. The requesting module must respond with an ACK and a data bit (on ID1–ID4) which is used as a priority vector by INT CONTROL.

3-18. Two types of resets may occur: software and hardware. Software resets are a result of front panel or remote requests. Hardware resets occur at power up or power down. Line frequency pulses from RT5 are sensed by the reset logic. At power up the reset signal assures that the microprocessor will start from program location zero. At power down the reset signal assures that the controller will not call up wrong modules.

3-19. The microprocessor control logic is responsible for latching up a status word at the beginning of each instruction cycle and for telling the microprocessor when to enter and exit wait states. Microprocessor sequences are divided into machine states (one clock period, 588 nsec), machine cycles (from three to five states) and instruction cycles (from one to five machine cycles). Status words are used to control and synchronize data I/O, memory read/write, and some of the interrupt control signals. The microprocessor must be instructed to enter a wait state after addressing an external module and after being interrupted to allow the external module time to respond.

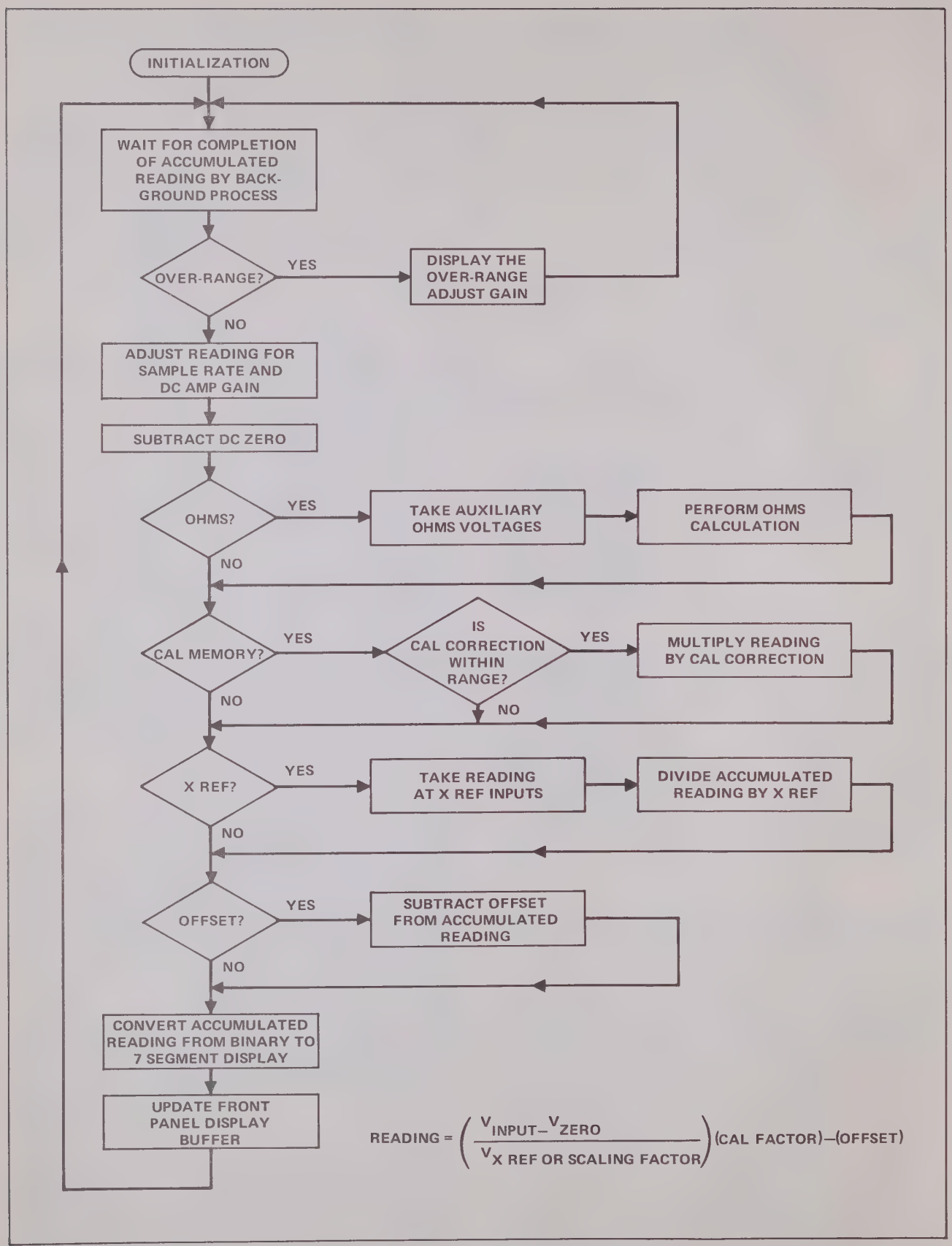


Figure 3-4. Foreground Software Process

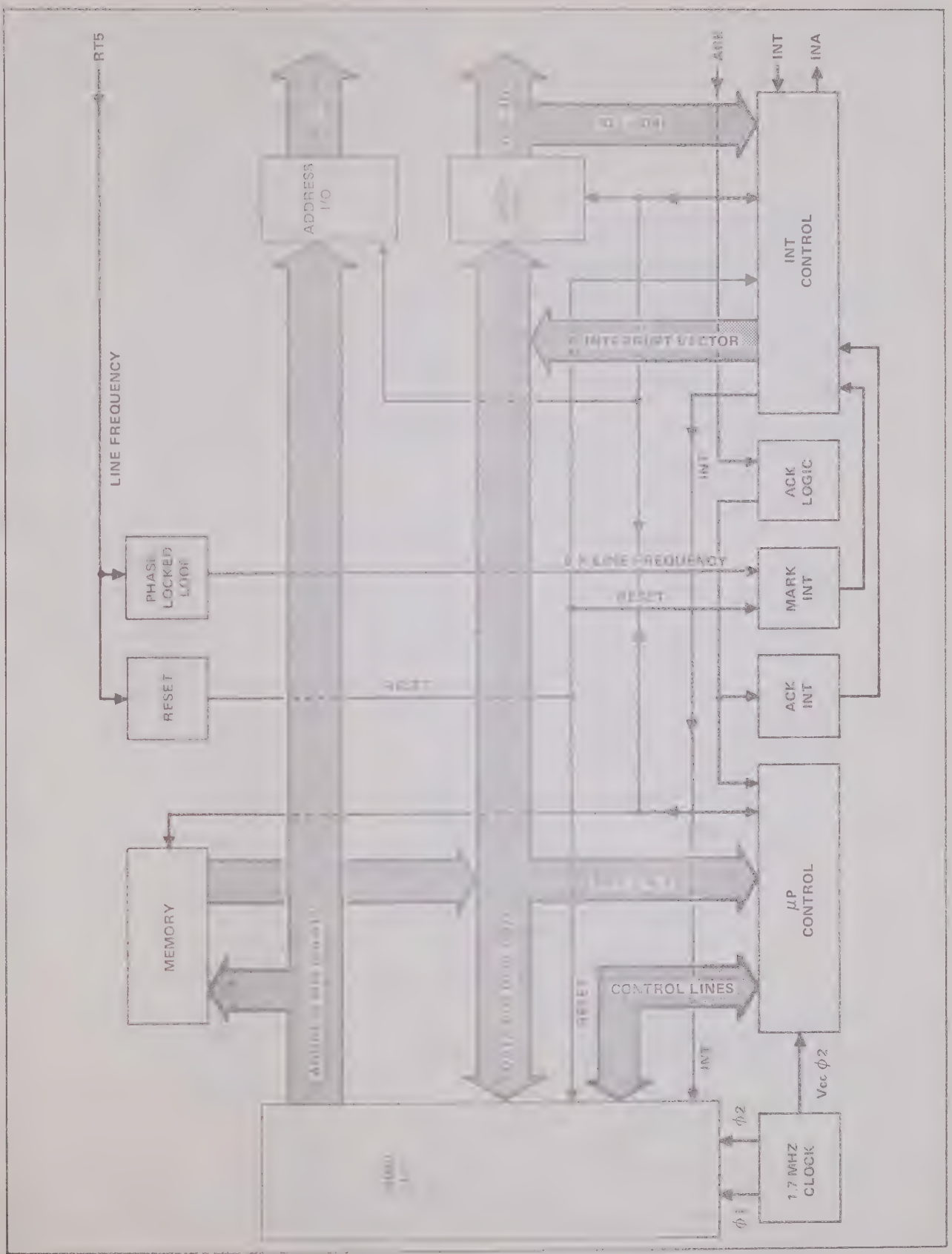


Figure 3-5. Controller Block Diagram

3-20. Front Panel

3-21. The front panel serves as an interface between the operator and the 8500A controller. The display is multiplexed by the controller by means of addressing the front panel for each digit. One direct address, two indirect addresses, and the accompanying data determine which digit or annunciator and which segments will light. An indirect address requires a previous, valid direct address to set up the indirect response. Another direct address enables the switch matrix to be read to determine if any function changes are desired. The cycle of updating each digit and annunciator and reading the switch matrix requires approximately 14 msec and is a continual cycle. Input terminals, J1–J5, are physically located on the front panel but have no electrical interaction with the front panel.

3-22. DC Signal Conditioner

3-23. DC signals from either the input terminals or optional signal conditioners (Ohms or Current Shunts) are routed through the DC Signal Conditioner to be brought within the range of the A/D Converter (± 20V). Figure 3-6 is a block diagram of the DC Signal Conditioner. For ease in arithmetic manipulations in the microprocessor, all gains or attenuations in the 8500A are powers of eight. Gain or attenuation factors are selected by the microprocessor addressing the module. Data from the data bus is latched into the control circuitry and used to select relays in the attenuator and switches in the amplifier feedback circuit. The combination of the attenuator and feedback-controlled amplifier give gain or attenuation factors of one, eight, or sixty-four.

3-24. Active Filter

3-25. The purpose of the Active Filter module is to multiplex dc signals to the A/D Converter and to switch analog filters into the signal conditioner inputs. Figure 3-7 is a block diagram of the Filter/External Reference module. Either the fast or the slow filter may be selected from the front panel. Both filters may be bypassed by

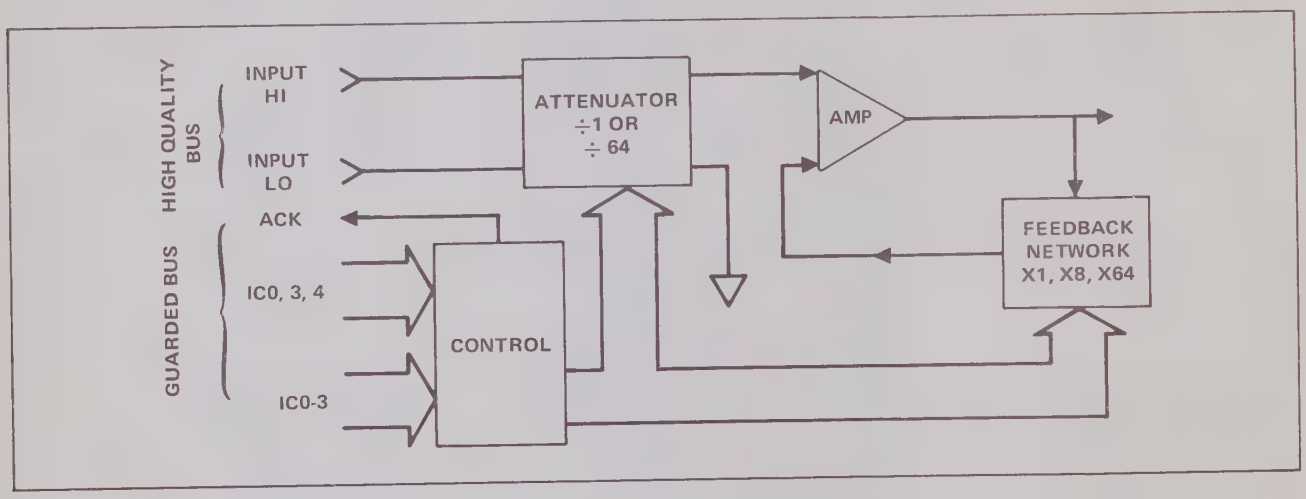


Figure 3-6. DC Signal Conditioner Block Diagram

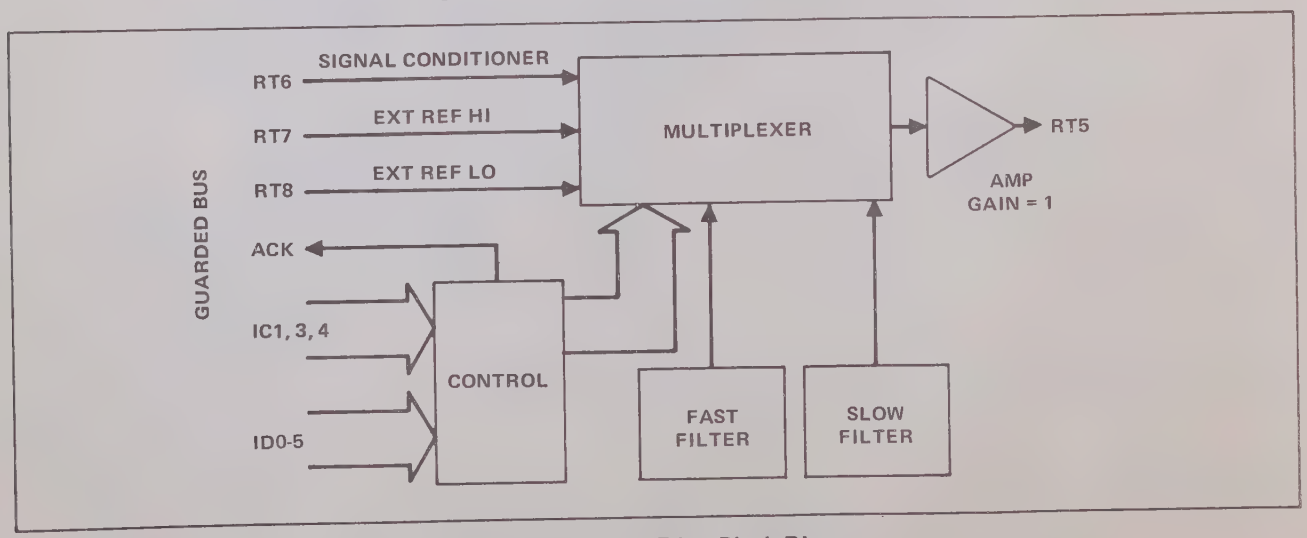


Figure 3-7. Active Filter Block Diagram

command from a remote interface. For external reference measurements, the signal conditioner input, the External Reference HI input and the External Reference LO input are multiplexed to the A/D Converter. Samples are taken of each input and arithmetically manipulated by the Controller to arrive at a reading. Outputs from the optional AC converter modules are applied to the Active Filter module, bypassing the DC Signal Conditioner.

3-26. Fast R^2 A/D Converter

3-27. The Fast R^2 A/D Converter employs Fluke's patented recirculating remainder (R^2) technique for converting a dc input signal into a binary, bit-serial data stream. The R^2 technique has been modified for microprocessor control. Obtaining a sample is a five-step process. Each step consists of a decision period of five decisions and a subtraction period. Set-up of the converter, decisions, and reset are initialized by the Controller addressing the A/D Converter. Figure 3-8 is a block diagram of the R^2 A/D Converter.

3-28. During the first step, the input signal is applied to the Summing Node. The polarity of the input is detected and that bit of information is transmitted to the Controller. On the basis of the returned polarity, the A/D module selects which reference polarity is required—positive for negative inputs, and vice versa. The first of five precision currents is switched into the Summing Node and a polarity bit returned. If the polarity changed, the first current is switched off. If not, it is left on. Then the next current is switched into the summing node and another polarity bit returned. Another decision is made and so on until all five currents have been switched into the summing node and five decisions have been made. This completes the first decision period. The five precision currents are related by powers of two. The fifth current has a resolution of thirty-two.

3-29. Following the decision period is a subtraction period. Feedback through the Remainder Storage nulls whatever remainder was left after the five currents have been switched into the summing node. The remainder is amplified by sixteen by the Remainder Amp and is stored on a capacitor in Remainder Storage. This completes the first step. The input is now switched out of the Summing Node and the amplified remainder switched in for the next step. There are two remainder channels in Remainder Storage and they are alternated in the four subsequent steps. Since the fifth current has a resolution of thirty-two and the remainder amp has a gain of sixteen, the first bit of a step has the same weight as the last bit of the previous step.

3-30. Of the five steps required to complete a sample, the first uses the input signal for decision and subtraction periods. The four subsequent steps alternate remainder channels to use the amplified remainder of the preceding step for decision and subtraction periods. Polarity bits

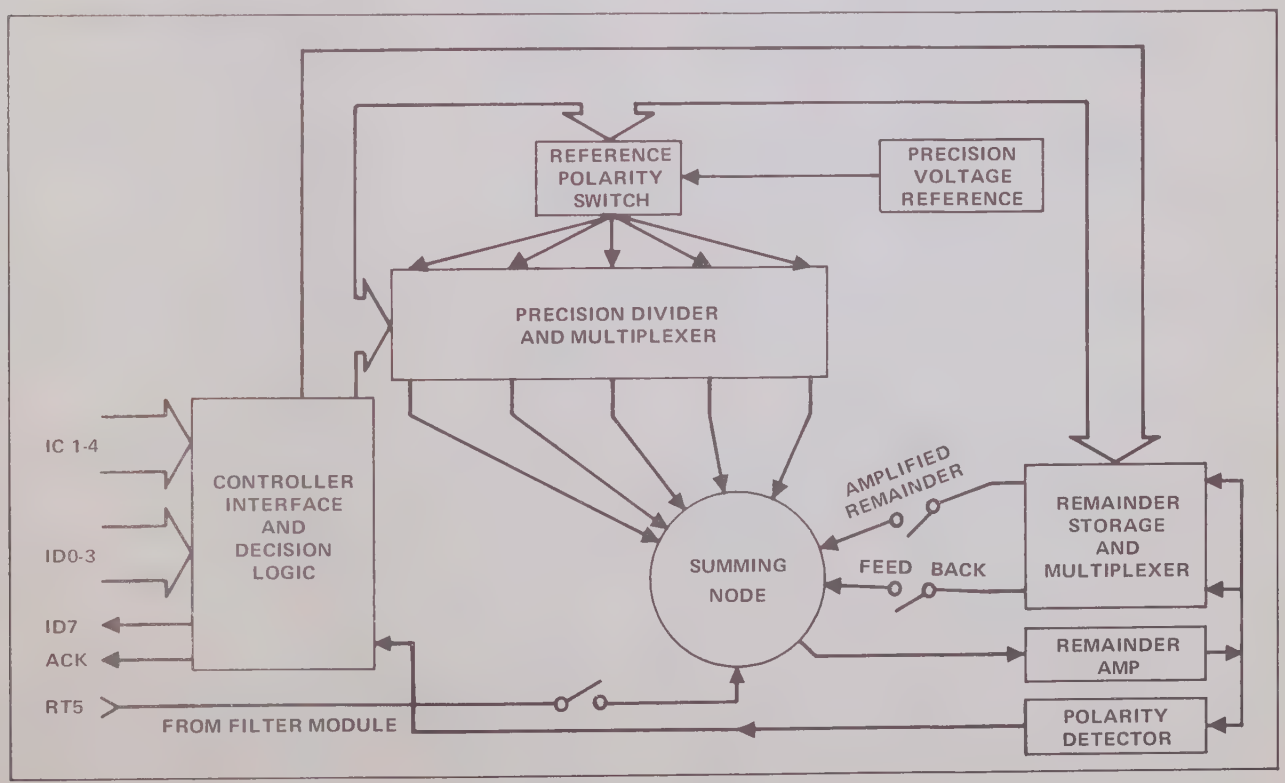


Figure 3-8. R^2 A/D Converter Block Diagram

returned at each decision are accumulated by the Controller and assembled into a 24-bit word describing the polarity and magnitude of the input.

3-31. CIRCUIT ANALYSIS

3-32. Introduction

3-33. The following circuit analyses detail the functioning of the circuitry composing each module in the 8500A mainframe. Optional modules are covered in Section 6. Block Diagram Description should be read first to get an understanding of the overall functioning of the instrument. Simplified schematic diagrams are referred to by figure number. Complete schematic diagrams are located in Section 8 (Section 6 for optional modules). Table 3-1 is a list of mnemonic definitions used in the Controller schematic.

3-34. Controller

3-35. TIMING

3-36. The 8080 microprocessor requires two 12V clock inputs whose phase relationship must fall within certain limits (Figure 3-9). The period of the $\phi 1$ clock (588 nsec) governs the duration of a machine state (3 to 5 states required for a machine cycle, 1 to 5 machine cycles required for an instruction cycle). A 1.7 MHz crystal oscillator is RC coupled through buffers and gates to provide the two-phase clock signal. R1 controls the positioning of the $\phi 1$ clock pulse (with respect to time) during the $\overline{\phi 2}$ pulse. The $\phi 2$ clock pulse is inverted and translated to 5 volt TTL levels for other timing functions in the control circuitry.

3-37. Shaped line pulses are applied to a phase-locked loop (U26) which runs at 8 times the line frequency (480 Hz for 60 Hz line, 400 Hz for 50 Hz line). U34 divides the output of U26 by 8 for application to a phase comparator contained in U26. Line synchronization is achieved using the output of the phase-locked loop to time the internal interrupt, MARK INT.

3-38. ADDRESS and DATA BUSSES

3-39. Sixteen address lines are used for addressing memory locations and external modules. Refer to the Controller schematic in Section 8. A0-A7 are used for internal scratch pad memory locations with A8, 9, 11, 12, 13 decoded as a RAM chip select. A0-A10 are used for internal ROM locations with A11, 12, 13 decoded as a ROM chip select. A14 is used as ROM/RAM select (high for RAM). A8-A14 are used for external addresses with A15 used as external/internal select (high for external). These address lines are inverted when driving the IC lines on the Interbus. The data bus is eight lines (DB0-7) connected directly to memory and to the external data bus (ID0-7) through tristate I/O buffers.

Table 3-1. Mnemonic Definitions

ACK	— acknowledge
ACK LAT	— acknowledge late
AR	— analog return
DB	— data bus
DBIN	— data bus input signal (from μP)
DLD ACK	— delayed ACK
EN INT	— enable interrupt
HLDA	— hold acknowledge
IB ADX	— interbus address
IBIN	— interbus input signal
IC	— interbus control
ID	— interbus data
IINT	— internal interrupt
INA	— interrupt acknowledge (from controller)
INT	— interrupt
INTA	— Interrupt acknowledge (status word from μP)
INTE	— interrupt enable (from μP)
MEM RD	— memory read
MS ADDR BYTE	— memory select address byte
$\phi 1$	— clock pulse
$\phi 2$	— clock pulse
ϕLL	— phase-locked loop
RAM	— random access memory
ROM	— read only memory
RRDY	— reset ready
RST	— reset
RT	— real time
R/$\overline{W}$	— read/$\overline{\text{write}}$
μP	— microprocessor
VA	— analog supply voltage
V_{CC} $\phi 2$	— 5V clock pulse
V_{DD} $\phi 2$	— 12V clock pulse
SRDY	— set ready
SYN IINT	— synchronized internal interrupt
TTL PU	— TTL pull-up
WO	— write out
WR	— write

3-40. RESET

3-41. Shaped line frequency pulses are applied to U36 and U34 to provide a reset on power up or power down (Figure 3-10). U36 is a retriggerable one-shot multivibrator which is cleared on power up by Delayed Vcc. Clearing U36 sets U35 to the Reset condition. After the clear on

U36 is removed (Delayed Vcc high), U34 clocks U35 out of the reset condition on the eighth line pulse. At power down, U36 changes state at a time determined by R18 and C22, setting U35 to the reset state.

3-42. STATUS LATCH

3-43. During the first state of every machine cycle, the microprocessor sends a status word out on the data bus. This is at the same time and duration as the SYNC output. SYNC $\overline{\phi 2}$ clocks the status word into a hex "D" latch, U18. Outputs from U18 (Figure 3-11) are used in various portions of the control circuitry.

3-44. WAIT LOGIC

3-45. When the microprocessor addresses an external module (A15 high) or is interrupted, the WAIT logic causes the microprocessor to enter a wait state by pulling the ready (RDY) line low (Figure 3-12). $\overline{\text{SRDY}}$ is normally high and is pulled low to exit the wait state. RRDY is normally low and goes high to enter the wait state. A15 TTL is high for an external address, so RRDY will go high at SYNC TTL (derived from the microprocessor). For interrupts, the interrupt enable (INTE) signal is inverted for application to U8. INTE enables INT and is removed before INT falls low (due to an RC delay in the INT CONTROL circuit) so that INT and $\overline{\text{INTE}}$ are high long enough to clock U1 for a wait signal.

3-46. Three possible combinations will cause the microprocessor to exit a wait state. If an ACK signal is missing, ACK INT TTL will pull $\overline{\text{SRDY}}$ low. For external addresses, and external interrupts, A15 + INTA and ACK LAT will pull $\overline{\text{SRDY}}$ low. For internal interrupts SYN IINT and

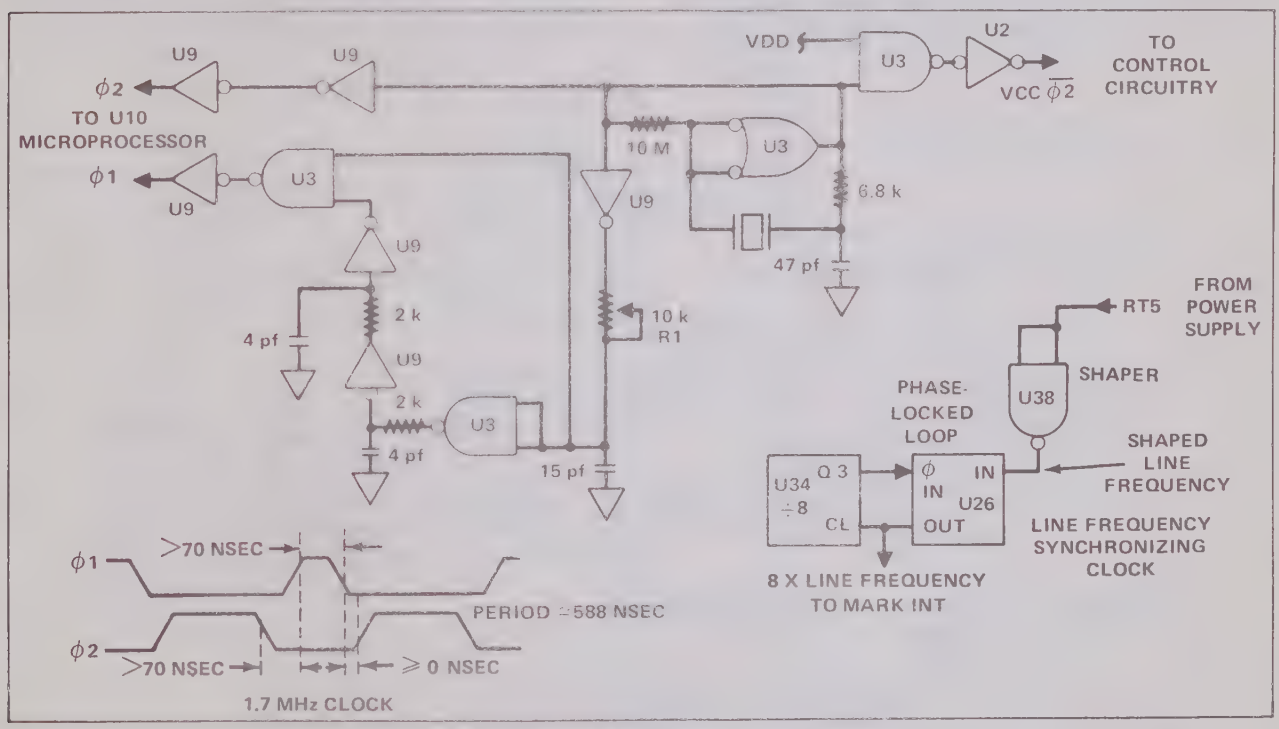


Figure 3-9. Timing Circuits

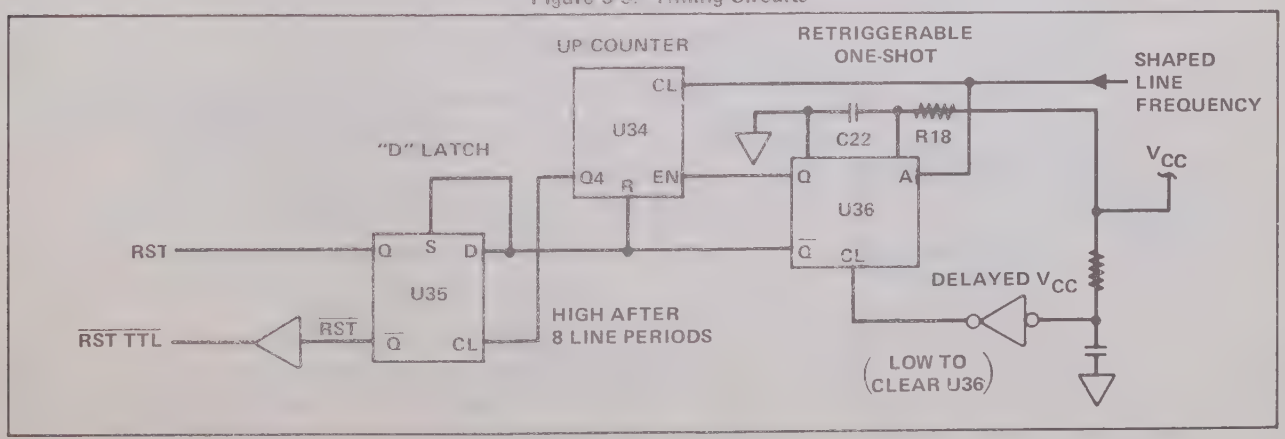


Figure 3-10. Reset Logic

INTA remove the wait state limiting the wait time to a single machine state.

3-47. ACK LOGIC

3-48. When a module is addressed by the Controller, or enabled for interrupt identification by INA from the Controller, it must return an ACK (high) signal. Refer to Figure 3-13. Either INTA (for interrupts) or A15 (for external addresses) together with the delayed ACK signal produce $\overline{\text{DLD ACK}}$ for U38. $\overline{\text{DLD ACK}}$ resets the ACK interrupt logic, which is timing the wait for ACK, and produces the ACK LAT signal through U15 and U27. RRDY must be low to get ACK LAT. This synchronizes ACK LAT to the SYNC TTL signal. ACK LAT (or $\overline{\text{ACK INT TTL}}$ if an ACK is missing) causes the microprocessor to exit the wait state.

3-49. INTERUPTS

3-50. Two internal interrupts and four possible external interrupts are applied to the interrupt (INT) control logic (Figure 3-13). A low on OR gate U17 places a high on NAND gate U38. When INTE is high from the microprocessor (during the last state of an instruction cycle), U38 outputs a low through an RC delay network to U32. U32 inverts the signal and places a high on the INT line to interrupt the microprocessor. The microprocessor drops INTE low, then puts out an interrupt acknowledge (INTA) as a status word which is latched up in the Status Latch, U18. Then the microprocessor enters a wait state until the interrupt and its priority are identified through INT VECTOR, U28 (Controller schematic, Section 8).

3-51. Internal interrupts are ACK INT and MARK INT (Figure 3-14). ACK INT logic consists of a retriggerable

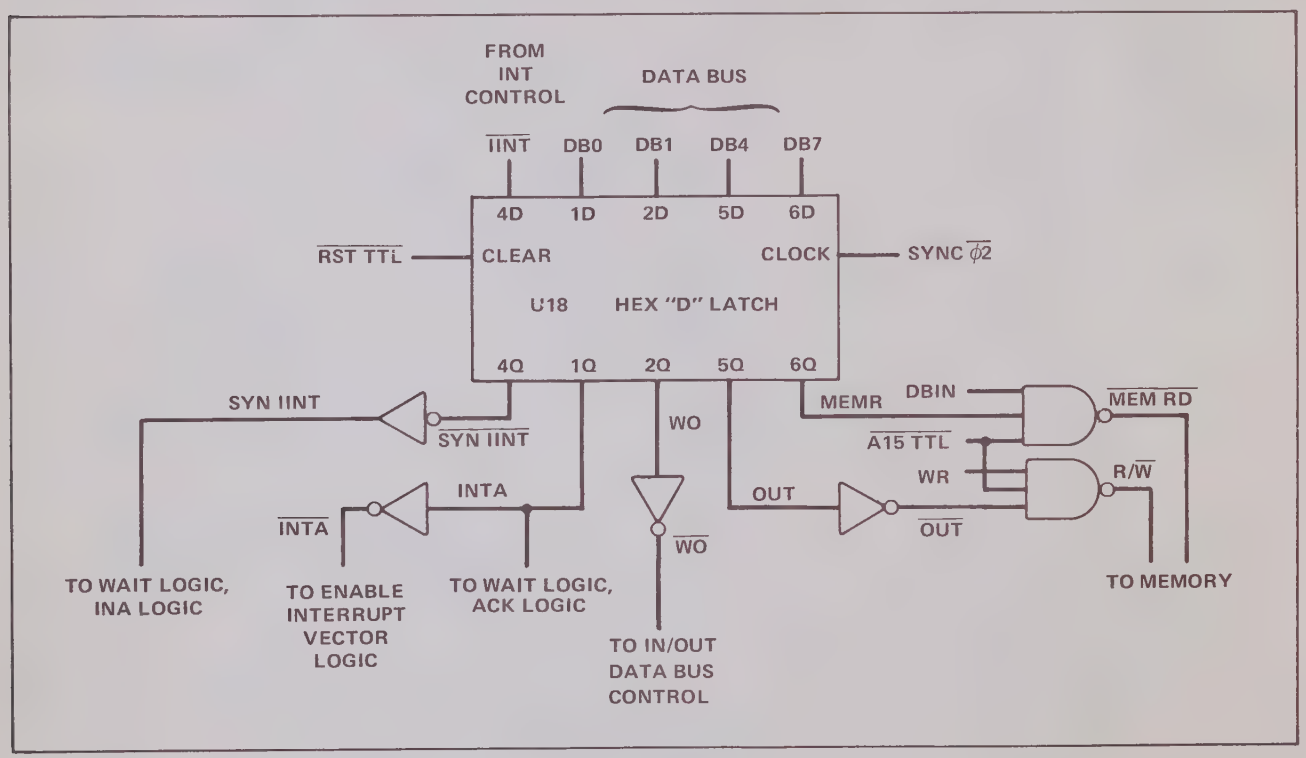


Figure 3-11. Status Latch

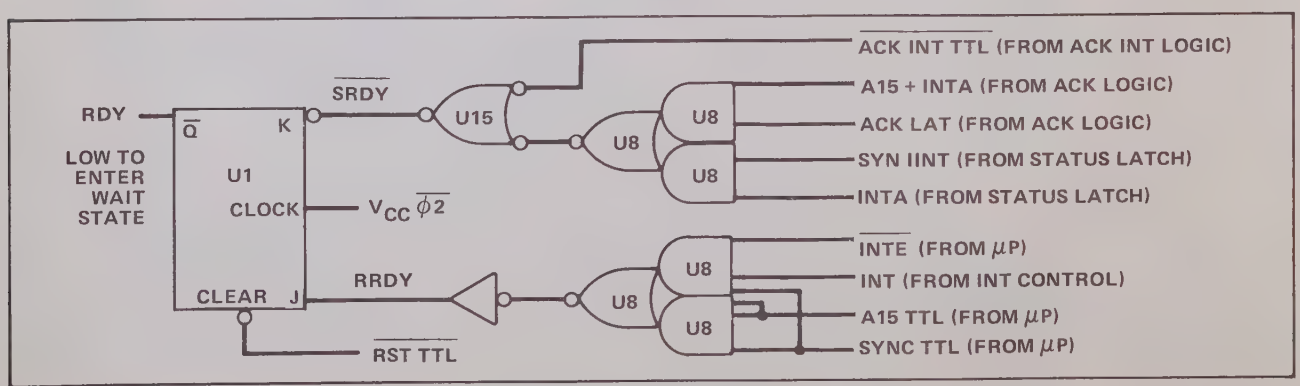


Figure 3-12. Wait Logic

monostable multivibrator, U36, and a "D" type flip-flop, U14. U36 is triggered by A15 TTL and SYNC $\overline{\phi 2}$. If $\overline{\text{DLD ACK}}$ does not occur within the time constant of U36, U36 will clock U14 to generate ACK INT. $\overline{\text{ACK INT TTL}}$ is also generated by U14 to end the wait state resulting from the external address.

3-52. The MARK INT logic is armed by an internal address keyed to RAM. A15 TTL is high indicating an internal address. DB4 is high as part of the status word indicating an address to an output device. $\overline{\text{A15 TTL}}$ and DB4 (both high) with SYNC $\overline{\phi 2}$ clock U1 through U31-12. $\overline{\text{A14}}$ is low for a RAM address so U1-7 is clocked high. Although the address which arms the mark is keyed to RAM, no data transfer takes place between the microprocessor and RAM. The write signal ($\overline{\text{R/W}}$) is disabled by OUT from the STATUS LATCH. $\overline{\text{MEM RD}}$ (memory read) is disabled by DBIN (from the microprocessor) and MEMR (from the STATUS LATCH) both being low. After ARM MARK (U1-7) is clocked high, the next pulse from the phase-locked loop timing circuit clocks U14 to generate the MARK INT signal.

3-53. Interrupts are prioritized through INT VECTOR (refer to Controller schematic, Section 8). Before entering a wait state after an interrupt, the microprocessor puts out a DBIN signal, signifying that it is ready to receive data. $\overline{\text{DBIN}}$ and $\overline{\text{INTA}}$ produce EN INT through U37 to enable the Interrupt Vector (U28). Internal interrupts are applied directly to U28 and have priorities of one (highest) for ACK INT and six (lowest) for MARK INT. For an internal interrupt, $\overline{\text{IINT}}$ is generated by one section of U38 (Figure 3-13) and, when latched into the Status Latch (U18), is used to end the wait state. For an external interrupt, SYN IINT is low and with $\overline{\text{EN INT}}$ low, INA is generated on the interbus. The interrupting module must respond with an

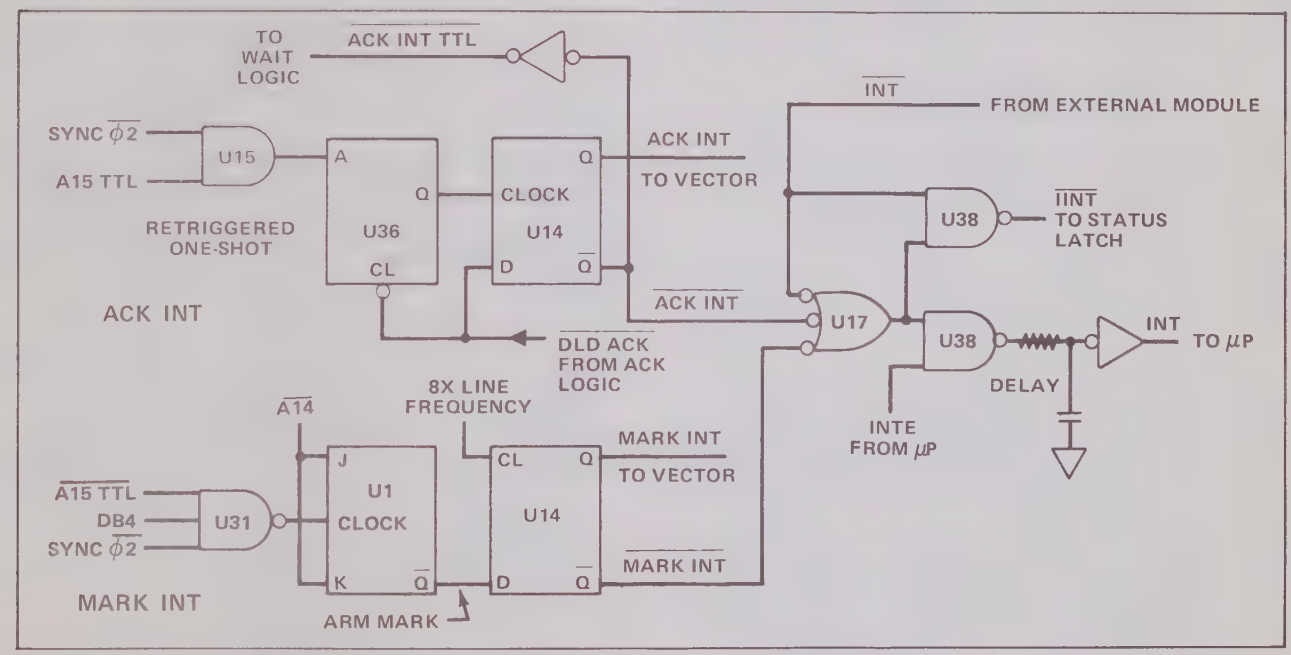


Figure 3-13. Internal Interrupts and INT Control

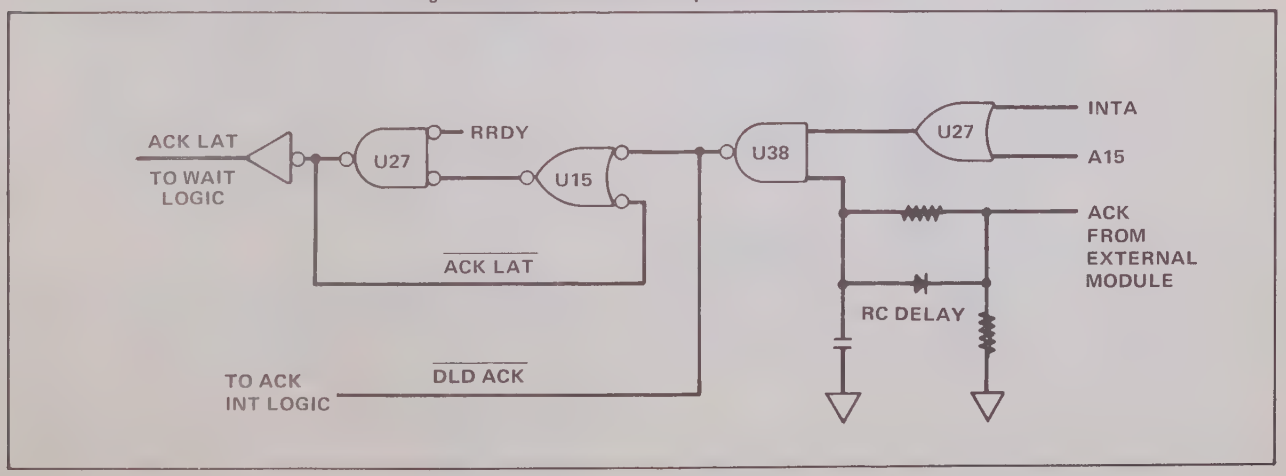


Figure 3-14. ACK Logic

ACK and a data bit on ID1-4. The returned ACK ends the wait state and the data bit is applied to INT VECTOR, U28. The complement of the output from U28 is placed on the data bus to instruct the microprocessor where to go for the next instruction.

3-54. Front Panel

3-55. Annunciator segment data is clocked into register one by the direct address, IC0, 1, 5 high. Refer to Figure 3-15. Data output from the switch matrix is also a direct address–IC0, 1, 6 high. For either direct address, the condition of ID7 (high for disable) is latched into U23 to enable an indirect address. Digit segment address–IC1, 5 high, and digit-annunciator select address–IC0, 5 are both indirect addresses. Data is clocked into the registers upon termination of the address. An update sequence is as follows:

1. Register one is addressed with all data lines low to blank the annunciator display and enable indirect addressing.
2. Register two is addressed indirectly with data lines low to blank the digit display.
3. Register three is addressed indirectly with all data lines high to turn off all LEDs, disable the switch matrix, and disable indirect addressing.
4. Register one is addressed with ID7 low to enable indirect addressing and with annunciator segment data on ID0-6. The data is latched and applied to the annunciator LEDs.
5. Register two is addressed with digit segment data on ID0-7 (U23 is not clocked by this address so ID7 may be high without disabling indirect addressing). The data is latched and applied to the digit LEDs.
6. Register three is addressed with ID7 high (disable indirect addressing) and one of the data lines, ID0-6, low to enable one digit LED and one annunciator LED. One bank of the switch matrix is also enabled.
7. The output buffer is addressed enabling the data from the previously enabled switch bank to be placed on the data bus. One or more lines low indicates a change is desired. This address also keeps the kill circuit charged.

3-56. The seven steps just outlined are required for one digit-annunciator-switch bank update. The process is repeated seven times for a complete update. The kill circuit is used to blank the display if the Controller discontinues addressing the front panel. Otherwise, segments would be left on continuously and would soon burn out.

3-57. DC Signal Conditioner

3-58. Relays K1 and K2 control the input to the DC Signal Conditioner and the attenuation of the input (Figure 3-16). If both relays are energized, the input is from the Volt/Ω input terminals with ÷ 64 attenuation. If just K1 is energized, the input is from the Volt/Ω input terminals with no attenuation. If just K2 is energized, the input is from RT1 (optional signal conditioners). Q10, Q11, CR3, and CR4 provide overvoltage protection.

3-59. Q18 and Q19 are configured as a differential amplifier driving U3. Q14, Q15, and Q16 are FET switches controlling the gain of Q18, Q19, and U3. U4, Q33, and Q37 provide bias for Q18 and Q19. U4 provides a bootstrap effect while Q33 and Q37 are a current sink and source. U5 and U6 provide bootstrapping for U3 and U4. Bootstrapping is used to provide an output voltage swing of ±20V without requiring high-voltage amplifiers.

3-60. The DC Signal Conditioner is addressed by IC0, 3, 4 high. Data on ID0-3 is latched up and decoded to determine which switches and relays will be energized. Figure 3-16 includes an example of the relay driver used to minimize thermal changes in the relays between the on and off states. RC coupling between the decoder and the relay driver provide voltage swings up to 4V or down to 0V to ensure positive relay action. Steady state voltages of 1.45V (off) and 2.75V (on) minimize current differences between the on and off states while maintaining the relay state under all conditions.

3-61. Filter/External Reference

3-62. All inputs to the A/D Converter are routed through the Filter/External Reference module. Refer to Figure 3-17. External reference measurements are made by multiplexing the three Filter module inputs to the A/D Converter. Q18, Q19, and Q20 switch the signal conditioner input, the external reference LO input, and the external reference HI input respectively. Data controlling the switches is latched into U1 upon termination of the address (IC1, 3, 4 high).

3-63. U3 and U4 are configured as three-pole, active Bessel filters having different settling times and cutoff points. Either filter may be selected from the front panel for application to the signal conditioner input. Bypass is automatically selected for external reference inputs or may be remotely selected for signal conditioner inputs. The combination of Q32 Q25, Q23 Q24, or Q21 Q22 is turned on to select a filter mode.

3-64. Q27 is a dual, super-beta transistor in a differential configuration driving U5. Q26 and Q30 are a current source and sink biasing Q27. Q26 draws enough current through R19 to bootstrap the input amplifier, Q27, 5V above the output. Gain of the amplifier is set at one by the combination of R21 and the input resistors. The external reference inputs have additional series resistors located at the rear panel terminals.

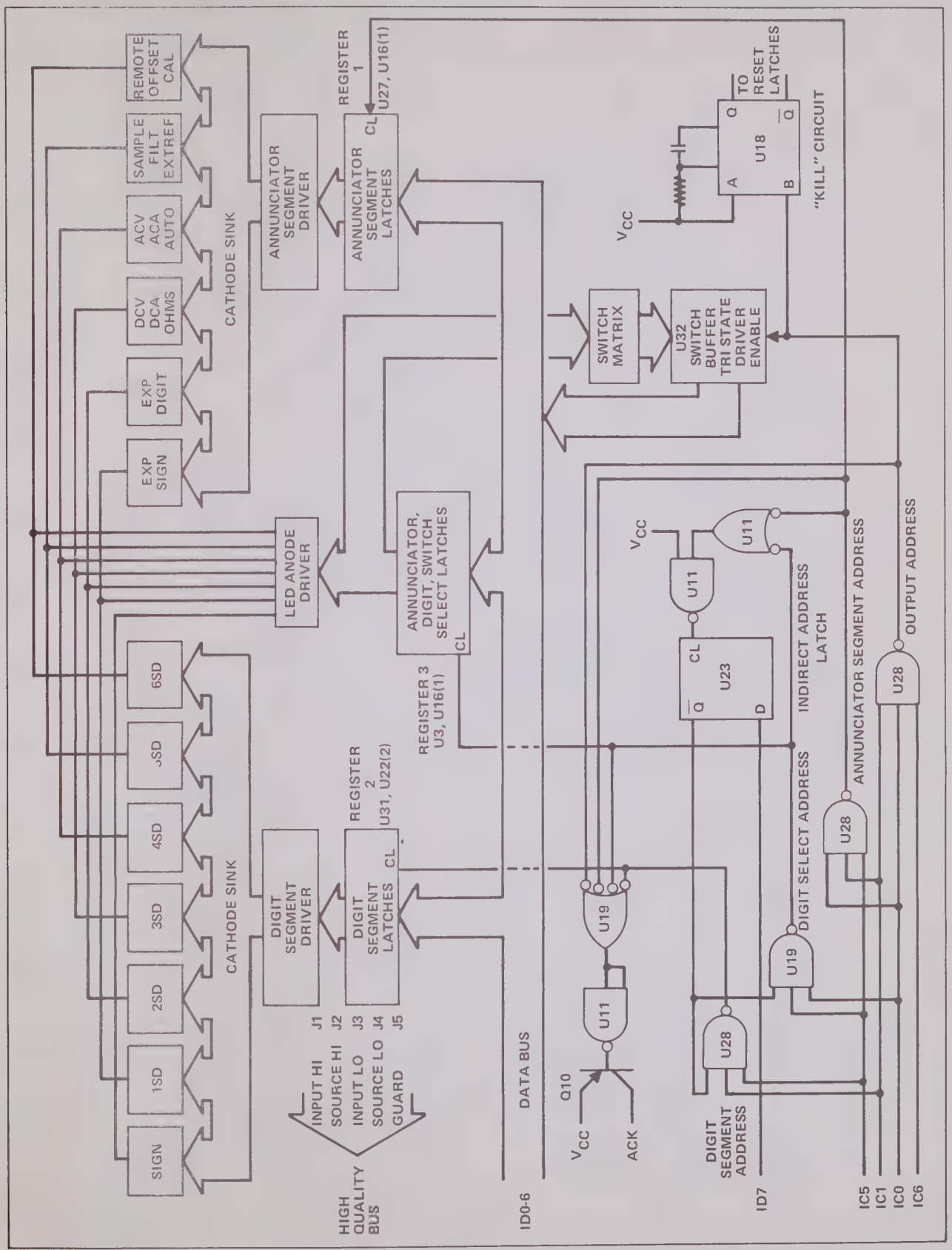


Figure 3-15. Front Panel

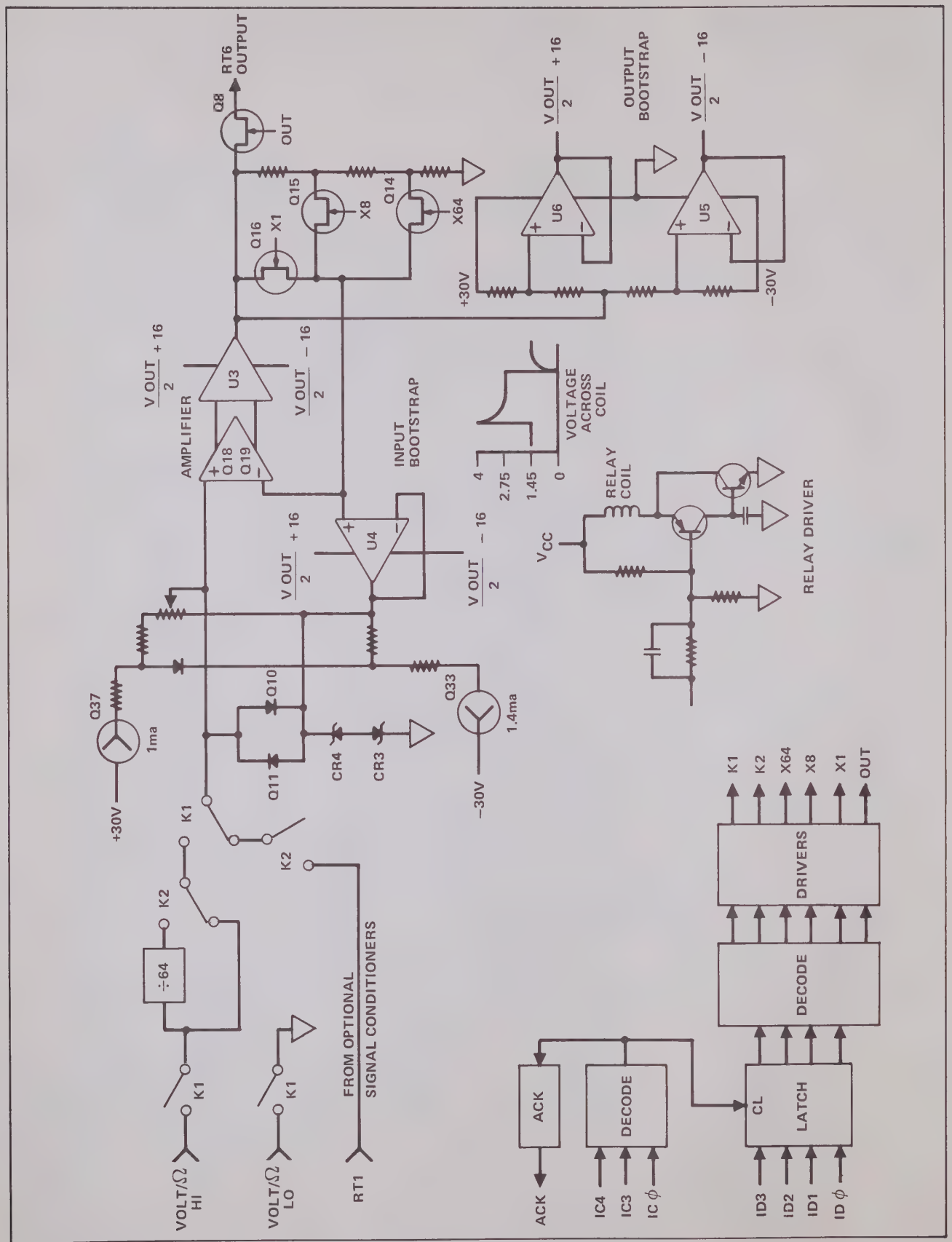


Figure 3-16. DC Signal Conditioner

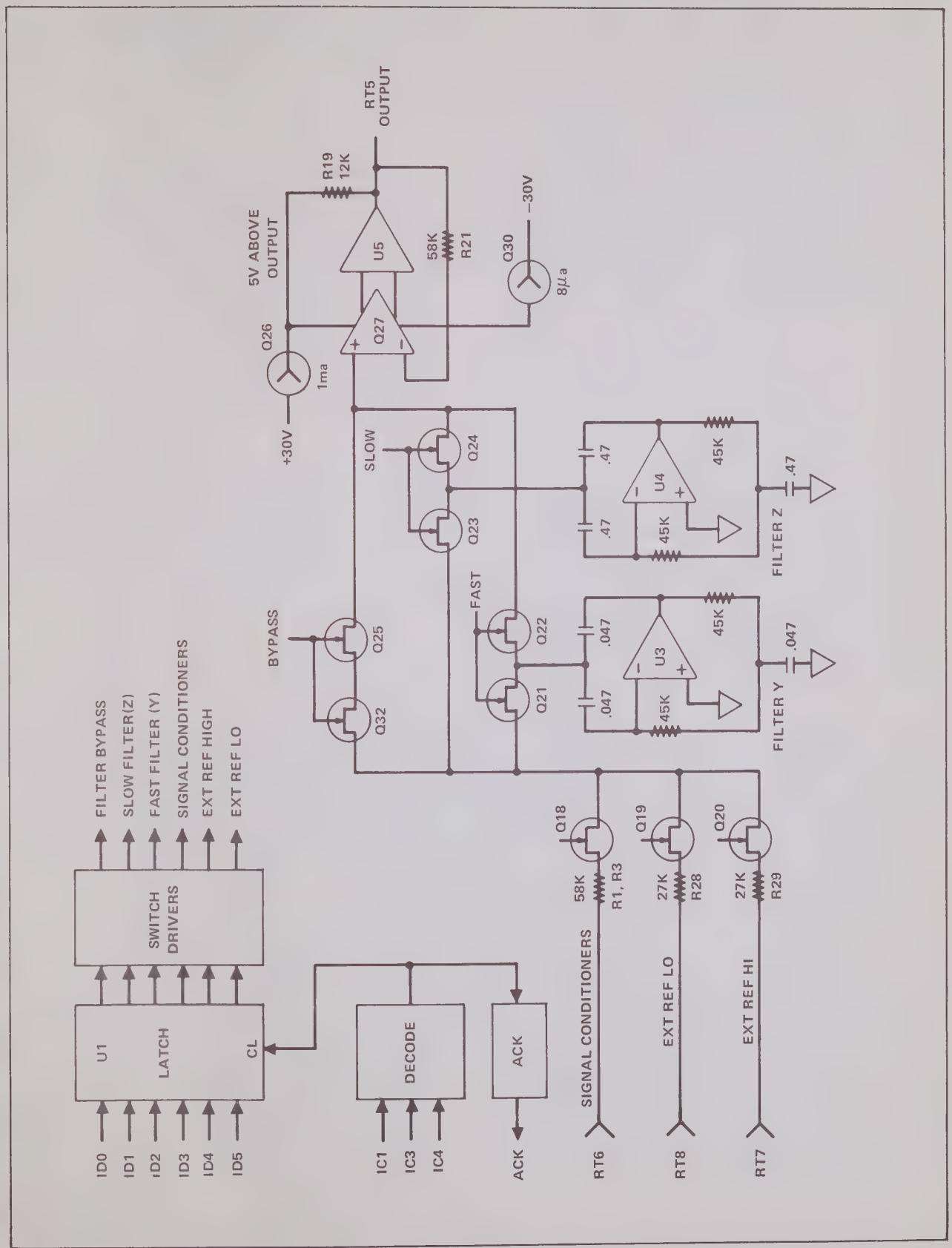


Figure 3-17. Filter/External Reference

3-65. Fast R^2 A/D Converter

3-66. The Fast R^2 A/D Converter may be separated for analysis into two component groups: Analog and Digital. Analog circuitry is responsible for producing a voltage reference, for summations, and for remainder amplification and storage. Digital circuitry interfaces the analog circuitry to the Controller and is responsible for reference selection, decisions in the summation process, remainder channel control, and autozeroing. Since functions within the A/D Converter are either directly controlled by the Controller module via the data bus or are clocked through their operations by the Controller addressing the A/D module, the A/D conversion program could be considered a functional part of the A/D Converter.

3-67. ANALOG

3-68. Figure 3-18 is a simplified schematic of the analog portion of the A/D Converter. For clarity, switches are shown as a circle enclosing a letter designator. U1 is a reference and reference amplifier controlling U2, a current source. The −7V reference is set by R9 and R14. U3 serves as a highly regulated collector and zener supply for U1. Operation of the D/A Converter requires both a positive and negative reference (for negative and positive inputs, respectively). Q9 and U4 are a precision unity gain amplifier whose input is controlled by switches A1 and A2. With A1 open and A2 closed, Q9 and U4 are configured as an inverting amplifier producing a positive reference. With A1 closed and A2 open, Q9 and U4 are a noninverting amplifier.

3-69. An input signal is applied to the summing node of the remainder amplifier (Q27, U7) through switch I. Q27 and U7 are an inverting amplifier with two gain configurations. During the decision period, switch G is closed, applying the output of U7 to polarity detector Q28 and forming a feedback path through CR5 and CR6. Q28 sends a polarity bit to the digital portion of the circuitry. On the basis of this first polarity bit, a reference polarity is selected.

3-70. Switches B, C, D, E, and F are closed, one at a time, to switch a precise amount of current into the summing node. When a switch is closed, the opposite switch is opened and vice versa. For example, when D is closed, $\overline{D}$ is opened. After a switch is closed, a polarity bit is returned. If the polarity changed with respect to the original polarity selected for a step, the switch is opened; otherwise it is left closed. The next switch is closed, a polarity bit returned and a decision made, and so on until all five switches have been closed (and possibly opened again). This constitutes a decision period.

3-71. Following the decision period is the subtraction period. Switch G is opened and switches X and SX are closed to form a feedback path for the remainder amplifier through the X channel. A 400K resistor, R35, sets the gain of Q27 and U7 at sixteen. The feedback current completes the summation process and the amplified remainder is stored on C10 in the X channel.

3-72. For the next decision period switches SX and X are opened and switches RX and G are closed. Since Q27 and U7 form an inverting amplifier, the opposite polarity reference (from the original selection) is automatically selected. The amplified remainder is applied to the summing node through U6 and R34. Five decisions are made, followed by a subtraction period using channel Y for feedback and remainder storage. The first decision-subtraction period applies the input signal to the summing node. The four following steps apply an amplified remainder, alternating between channel X and channel Y.

3-73. When a sample is complete, the circuits are autozeroed. U8 zeros the remainder amplifier through channel X. Any offset is stored on C13 at the noninverting input of Q27. The switching reference, Q9 and U4, is zeroed by first closing A1 and opening A2 to decrease settling time. Then A1 and A2 are both opened and the Z1 and Z2 switches are closed, storing any offset error on C5.

3-74. DIGITAL

3-75. For the following discussion, refer to the Digital Fast R^2 A/D schematic in Section 8. Direct address IC2, 3, 4 latches data into U34 and U35 controlling input switch I, remainder channel switches, autozero, and reset (digital). U31, a ring counter, is clocked to the C1 state enabling the indirect address decoder (U33) and the polarity detector (switch G). A polarity bit is returned and applied to U6.

3-76. Indirect address IC1, 2 latches the polarity bit in U6, enables the tristate transmitter, U5, and clocks U31 to the C2 state. The transition of U31 from C1 to C2 clocks the polarity into U11 (the uppermost section) whose output determines whether switch A1 or A2 will be closed (reference polarity). At the same time, U1 (uppermost section) is clocked to set the other section of U11, closing the first reference switch, B, of the D/A Converter. The next indirect address clocks a new polarity bit (a result of closing the first reference switch B) into U6. If the polarity changed, the output of U6 will cause a reset of the previous switch latch, opening the previous switch. At termination of the address the next switch is closed. One direct address and six indirect addresses are required to complete a step. The last indirect address resets the control logic to the C0 state.

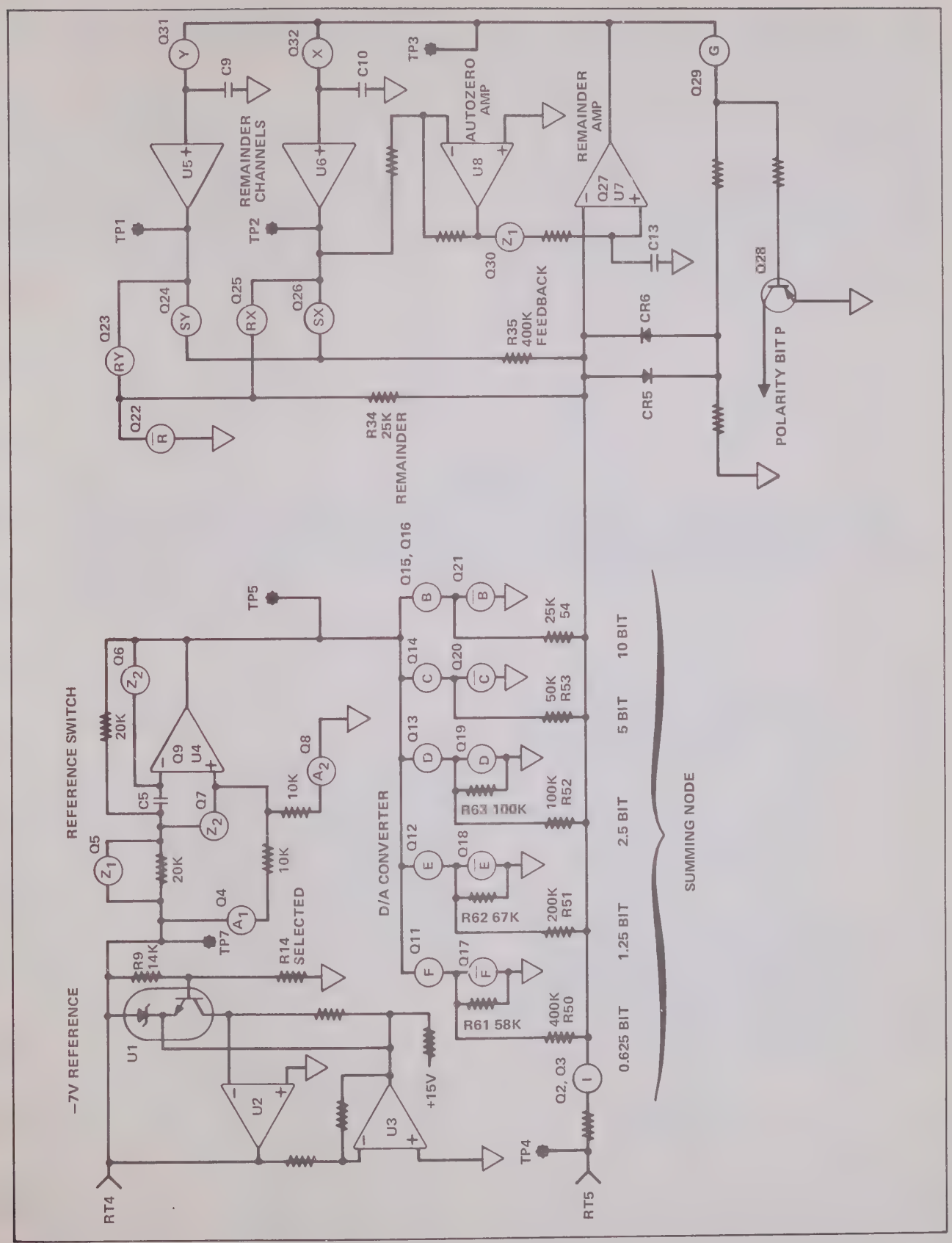


Figure 3-18. Fast R^2 A/D Converter (Analog)

3-77. Switch selections are made through switch drivers which rely on Vcc and Vss being at −15V and −20V with respect to analog common. This allows simple transition from TTL levels to FET off voltages. D/A Converter switches are selected on transition of U31 from one state to the next. The transition clocks the first of two "D" flip-flops which sets the second. The output of the second latch resets the first and selects the switch. If the polarity does not change after closing a switch, the output of U6 plus the output of U11 (reference select) will place two highs on the input of one section of AND gate U25. Through OR gate, U16, a one will be applied to the D input of that switch latch. The next transition of U31 will clock the latch, keeping the switch closed. If the polarity had changed, a zero would be applied to the D input, opening the switch.

3-78. After the last step, at completion of a sample, the Controller addresses the A/D Converter for autozero. U31 is clocked to the C7 state causing a digital reset. When U6, storage capacitor disable, is reset, autozero is enabled. RC coupled gates delay the zero switch controls so that switch A1 may be closed and A2 opened in the reference switching circuit. This provides a faster settling time for the reference switching amplifier. Both A1 and A2 are opened during the autozero time.

Section 4
Maintenance

WARNING!

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains performance tests, calibration procedures, and maintenance information including general maintenance and troubleshooting. Calibration intervals may be determined by the user according to the accuracy desired (specifications are listed in Section 2). One year is the recommended maximum calibration interval. Test equipment recommended for performance tests, calibration adjustments, and troubleshooting is listed in Table 4-1. If the recommended equipment is not available, equipment of equivalent specifications may be used.

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of domestic service centers is located in Section 7 of the manual. Shipping information is given in Section 2. If requested, the customer will be provided an estimate before any work begins on instruments that are beyond the Warranty period.

4-6. GENERAL MAINTENANCE

4-7. Line Voltage Selection

4-8. Input line voltage is switch selectable between 115V ac and 230V ac (check Section 2 for line voltage and frequency limitations). Removal of the top cover of the instrument allows access to the switch, located in the left front corner on the power supply board. Turn off the power and disconnect the line cord before removing the cover.

4-9. Fuse Replacement

4-10. The line fuse is located on the rear panel of the instrument near the heat sink. Use an MDL ½A fuse for replacement. The current protection fuse is located on the front panel near the input jacks. Use an AGC 1½A fuse for replacement.

Table 4-1. Test Equipment

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC Source	High Short-Term Stability Range: 0 – 1100V	Fluke Model 335A
Null Detector	10 μV Full-Scale Resolution	Fluke Model 335A
Reference Divider	±.001% Division Accuracy	Fluke Model 750A
Kelvin-Varley Divider	Linearity: ±.1 PPM of Input	Fluke Model 720A
Standard Cell Enclosure	Guildline 91	Guildline 9152 (R)
Oscilloscope	General Purpose with 10MΩ Probe	Tektronix 465
Digital Multimeter	Voltage Accuracy: .01% Input Impedance: 1000 MΩ	Fluke Model 8800A
Low EMF, Shielded Connector Cables	Gold-plated Spade Lug Connectors	
Extender Card		Fluke Model MIS-7011k
Bus Monitor		Fluke Model MIS-7013k
AS REQUIRED BY INSTALLED OPTIONS		
AC Calibration System	Voltage Range: 0 – 1000V ac Frequency Range: 10 Hz – 300 kHz Accuracy: 10 Hz – 30 Hz: .1 % 30 Hz – 20 kHz: .02% 20 kHz – 100 kHz: .05% 100 kHz – 300 kHz: .33%	Fluke Model 5200A with Fluke Model 5215A or with Fluke Model 5205A
Current Calibrator with 200 kΩ Resistor	Accuracy: ±.02% ±.01 %	Fluke Model 382A
Standard Resistors	10Ω at 30 ppm; 100Ω, 1.9kΩ, 10kΩ, 100 kΩ, 250kΩ, 1 MΩ, 4 MΩ at 10 ppm; 10 MΩ at 50 ppm; 100 MΩ at 100 ppm	ESI SR-1010 ESI SR-1050
Terminating Load	1 MΩ ± 10%/0.22 μf Nonpolarized Parallel Load	

4-11. Module Installation and Removal

4-12. Use the following procedure to install or remove modules in the 8500A.

1. Turn off the power and disconnect the line cord.

2. Remove the top cover from the instrument.

3. To install a module, select a slot according to Figure 8-2, which shows the permissable and preferred slots for each module. Slide the module vertically between the module guides and press firmly into place.

4. Open the hinged module top. Make sure the spring guard connection is resting on the guard shield (connecting one half of the guard shield to the other).

5. To remove a module, grasp the module at either end and pull up. An end-to-end rocking motion may be used to free the module from the connector.

4-13. Front Panel PCB Removal and LED Replacement

4-14. To remove the Front Panel PCB from the instrument for troubleshooting, repair, or LED replacement, use the following procedure:

1. Ensure that the power is removed from the 8500A.
2. Remove any shorting links from the input terminals.
3. Snap the bezel loose from the frame and remove it from the instrument.
4. Remove any defective LEDs from their sockets and replace.
5. If only LED replacement is required, reassemble in the reverse order. If removal of the Front Panel PCB is required, remove the top covers, remove the pcb retainer from the instrument, then unplug the front panel pcb from the motherboard and remove it from the instrument through the front framework.
7. Reassemble the Front Panel in the reverse order.

4-15. Power Supply Removal

4-16. Remove the Power Supply from the 8500A using the following procedure:

1. Ensure that the power is removed from the 8500A. Remove the top cover.
2. Remove the four screws positioned around the heat sink that secure the power supply to the rear frame.
3. Pull the Power Supply straight back, using a gentle rocking motion to disconnect it from the card edge connector on the interconnect pcb.
4. Reassemble in the reverse order.

4-17. Power Supply Interconnect PCB Removal

4-18. Remove the Power Supply Interconnect pcb from the 8500A using the following procedure:

1. Remove the Front Panel pcb as described above if not already done.
2. Remove the three screws securing the interconnect pcb to the framework.
3. Disconnect the pcb's card edge connector from the power supply and from the motherboard card edge connector. Lift the pcb out through the front framework, taking care not to damage the power switch.
4. Reassemble in the reverse order.

4-19. Motherboard PCB Removal

4-20. Remove the Motherboard PCB from the 8500A using the following procedure:

1. Remove the modules, the front panel pcb, and power supply interconnect pcb from the instrument if not already done.
2. Remove the eight screws that secure the motherboard to the bottom framework and lift the motherboard out through the front framework of the instrument.
3. Reassemble in the reverse order.

4-21. Cleaning Instructions

4-22. Periodically (at least every 90 days) clean the 8500A using the following procedure:

1. Ensure that the power is removed from the 8500A.
2. Remove the top and bottom covers from the instrument.
3. Disconnect the modules from the motherboard and remove them from the instrument.
4. Clean the interior of the 8500A using low pressure clean dry air or a vacuum cleaner.
5. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.
6. Replace the modules and covers if access to the instrument interior is no longer required.

4-23. PERFORMANCE TEST

4-24. Introduction

4-25. The following paragraphs contain a Performance Verification Test which compares the operation of the instrument to the specifications in Section 1 of this manual. The test may be used to verify calibration of the equipment between scheduled calibration periods or as an aid in troubleshooting.

4-26. The test equipment required for the Performance Test is listed in Table 4-1. If the recommended equipment is not available, replacements with equivalent specification may be substituted.

4-27. If the instrument does not meet the specifications listed in the Performance Test, either the calibration procedure or corrective maintenance should be performed, as determined by the symptoms. The test should be performed when the ambient temperature is between 18° and 28° Celsius and the relative humidity less than 75% to attain maximum accuracy.

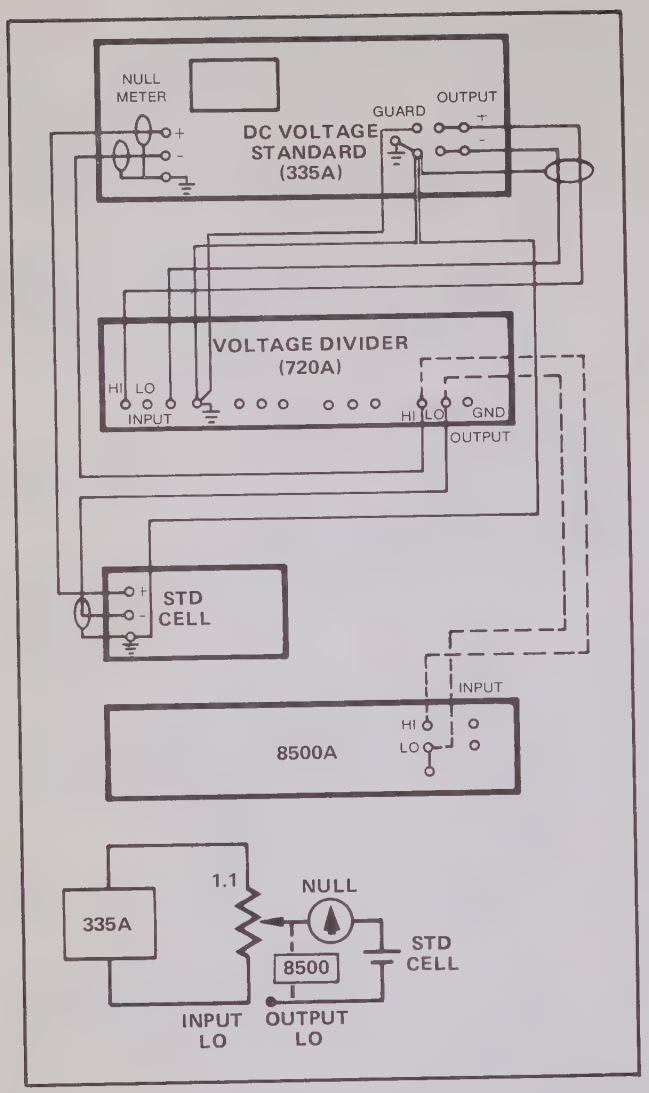


Figure 4-1. Connections For Low Range DC Voltage Tests

4-28. DC Performance Test

4-29. LOW RANGE DC VOLTAGE TESTS

4-30. Perform the Low Range Tests as follows:

1. Connect the equipment shown with solid lines in Figure 4-1. Do not connect the 8500A at this time.

2. Verify that the test equipment is operating properly and their respective warmup periods, as stated in the applicable manuals, have expired.

3. Verify that the 8500A warmup period of one hour has elapsed. Ensure that the VDC and AUTO indicators are illuminated, the SAMPLE indicator flahses approximately eight times per second (32 samples per reading), and all other indicators are extinguished.

4. Set the Voltage Divider controls for one-tenth the standard cell certified value. Adjust the DC Voltage Standard output for a null on the null meter.

5. Disconnect the leads at the Voltage Divider output terminals and connect the 8500A as shown with the broken lines in Figure 4-1.

6. Perform the test listed in Table 4-2, setting the Voltage Divider to the listed outputs. Do not change the output setting of the DC Voltage Standard. After voltage has been applied to the 8500A, but prior to the first reading, toggle the instrument into manual ranging.

7. Reverse the leads at the 335A output terminals (lead previously connected to the HI terminal now connected to the LO terminal and vice versa) and repeat the test listed in Table 4-2, ensuring that the listed outputs are now negative.

Table 4-2. Low Range DC Voltage Tests

RANGE	DIVIDER SETTING	8500A READING	
		LOW	HIGH
100 mV	.0010000	+ 9.995 (1–3)	+ 10.005 (–3)
100 mV	.0100000	+99.992 (–3)	+100.008 (–3)
1 V	.0100000	+ 0.09999	+ 0.10001
1 V	.1000000	+ 0.99997	+ 1.00003
10 V	.1000000	+ 0.9999	+ 1.0001
10 V	1.0000000	+ 9.9998	+ 10.0002

4-31. HIGH RANGE DC VOLTAGE TESTS

4-32. Perform the High Range Test as follows:

1. Connect the equipment as shown in Figure 4-2.

2. Verify that the test equipment is operating properly and any warmup period required has expired.

3. Verify that the 8500A warmup period of one hour is complete. Ensure that the VDC ⎓ function is selected with the VDC indicator illuminated and that the instrument is in manual ranging in the 100 volt range. The SAMPLE indicator should be flashing approximately eight times per second (32 samples per reading) and all other indicators should be extinguished.

4. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 10 volts.

5. Set the DC Voltage Standard to approximately 10 volts, then adjust its output for a null reading on the null meter.

6. The 8500A reading displayed is between + 9.999 and + 10.001.
7. Set the Reference Divider input and output controls to 100 volts.
8. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null reading on the null meter.
9. The 8500A reading displayed is between + 99.997 and + 100.003.
10. Increment the 8500A range manually to 1000 volts.
11. The 8500A reading displayed is between + 99.99 and + 100.01.
12. Set the Reference Divider input and output controls to 1000 volts.
13. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null reading on the null meter.
14. The 8500A reading displayed is between + 999.97 and + 1000.03.
15. Set the DC Voltage Standard to standby.
16. Reverse the leads at the DC Voltage Standard and standard cell terminals (lead previously HI to LO and vice versa).
17. Set the DC Voltage Standard to operate and repeat steps 4 through 17, ensuring that the listed outputs are now negative.

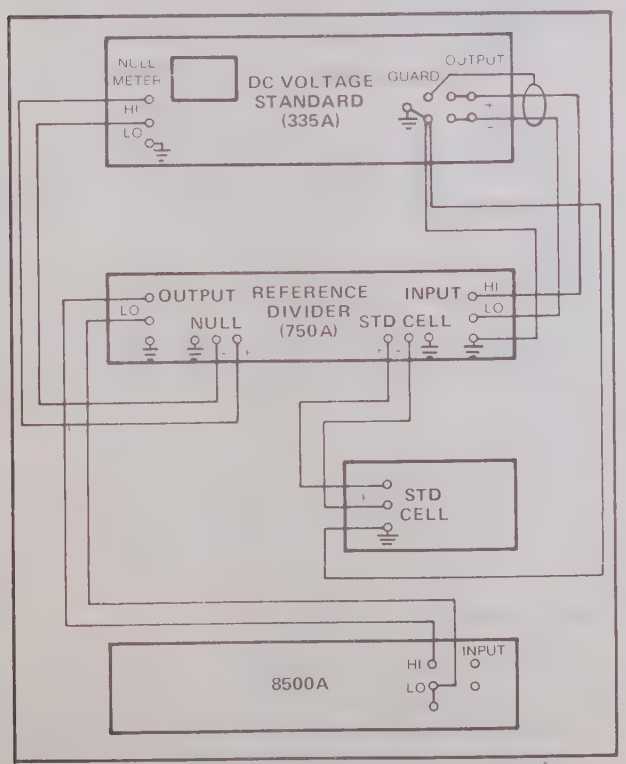


Figure 4-2. Connections For High Range DC Voltage Tests

4-33. AUTORANGING TEST

4-34. Test the autoranging capability of the 8500A with the following procedure:

1. Verify that the DC Volts and Autoranging modes are selected on the 8500A.
2. Connect the 8500A input directly to the DC Voltage Standard output.
3. Vary the output of the voltage source through its range, checking that the instrument autoranges approximately at the points indicated in Table 4-3.

Table 4-3. Autoranging

8500A CHANGES RANGE		NOMINAL READING
FROM	TO	
100 mV	1 V	312.5 mV
1 V	10 V	2.5 V
10 V	100 V	20 V
100 V	1000 V	160 V
1000 V	100 V	120 V
100 V	10 V	15
10 V	1 V	1.875
1 V	100 mV	0.234375

4-35. DC EXTERNAL REFERENCE

4-36. Test the DC four wire true ratio, using the following procedure:

1. Connect the test equipment to the 8500A as shown in Figure 4-3.
2. Select the VDC function and Autoranging on the 8500A.
3. Set the DC Voltage Standard controls for + 10.0000 volt output and the Voltage Divider controls to 1.000000.
4. Depress and hold the EXT REF switch. As long as the switch is held, the 8500A display reads the External Reference input of 10 volts (between 9.9998 and 10.0002).
5. Release the EXT REF switch. The 8500A computes the ratio (V_{IN}/V_{REF}) and displays a reading between 0.99996 and 1.00004.
6. Set the Voltage Divider controls to 0.1000000.
7. The 8500A displays a reading between 99.9995 (–3) and 100.005 (–3).
8. Depress the EXT REF switch to toggle the 8500A out of the External Reference mode.
9. Remove power from the test equipment and disconnect it from the 8500A.

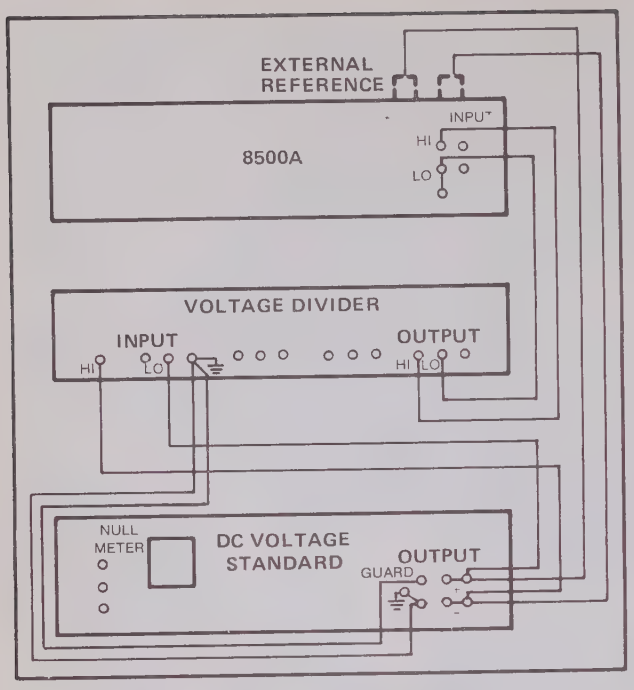


Figure 4-3. DC External Reference Test

4-37. CALIBRATION PROCEDURES

NOTE

The standards called out in the following procedure are required to meet the published specifications. If this accuracy is not required for a particular function (e.g., Resistance, DC Current, etc.), standards with a lower rated accuracy may be used. The accuracy of the 8500A function will then be based on the accuracy of the standard used, rather than the published specifications.

4-38. Introduction

4-39. The 8500A should be calibrated every 90 days or 1 year, as required to meet the applicable accuracy specifications. It should also be recalibrated any time that repairs are made to the instrument. When performing the calibration, the ambient temperature should be 23°C ± 2°C and the relative humidity should be less than 75%. Refer to Table 4-1 for the recommended test equipment. Check the instruction manuals for the various pieces of test equipment for the correct warmup periods. Power Supply adjustments are shown in Figure 4-4. Adjustments and test points on the remaining pcbs are accessible on the top edge of the board by popping open the hinged module top. Adjustments are labeled on the underside of the module top.

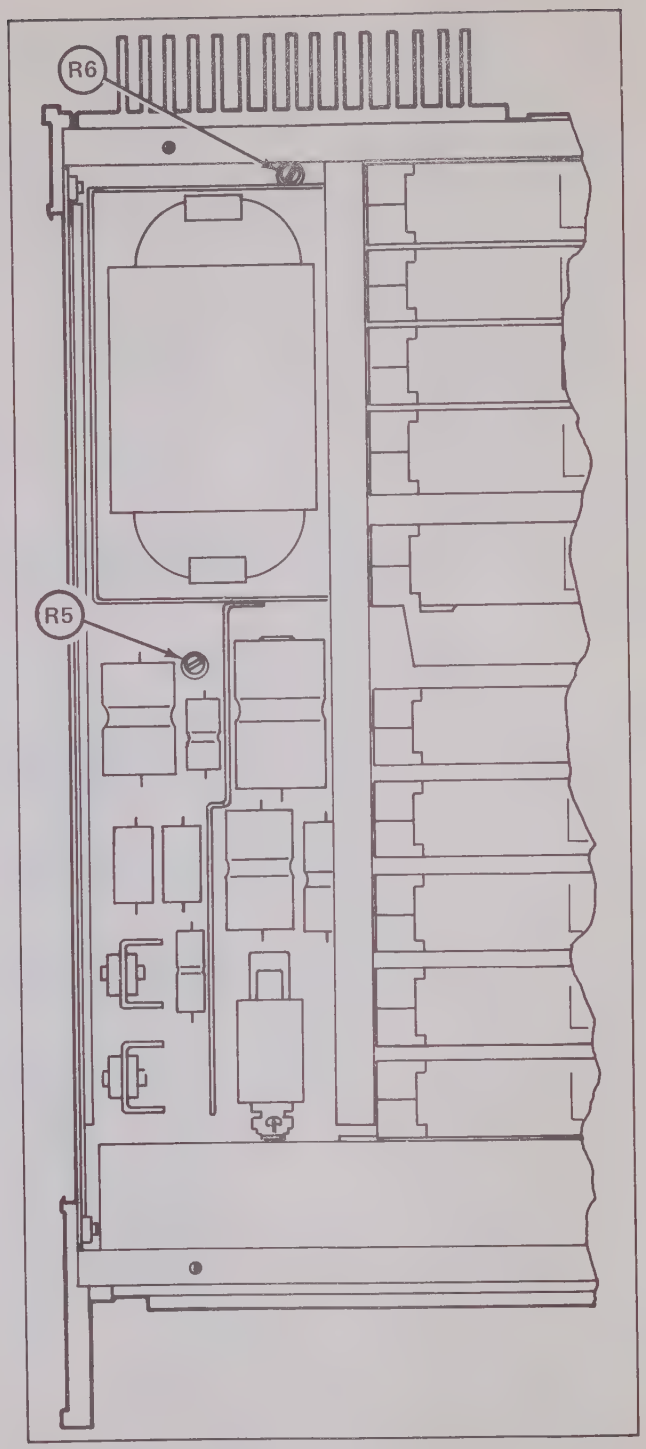


Figure 4-4. Power Supply Adjustments

4-40. Preliminary Operations

1. With the POWER switch OFF, replace the Isolator or Bus Interconnect, whichever is installed, with the Bus Interconnect and Monitor pcb assembly MIS-7013K. Remove the CAL Memory if installed.

After completing calibration, reinstall the CAL Memory and enter new calibration factors (should be zeros).

2. Set the POWER switch to ON and allow the instrument to warm up for at least one hour before continuing with the calibration.

4-41. Power Supply

4-42. Perform the Power Supply checks and adjustments as follows:

CAUTION!
Do not use the 8500A to check its own supplies.

1. Connect the test DMM HI input to Vcc on the Bus Interconnect and Monitor pcb and the LO input to Vss.
2. Adjust R6 for a reading between +5.00 and +5.10V dc to set the Logic Supply.
3. Transfer the HI DMM input lead to VA2.
4. Adjust R5 for a reading between +5.00 and +5.10V dc to set the Analog Supply.
5. Verify that the voltages in Table 4-4 are within the prescribed limits.
6. Prepare the test DMM to read AC volts and verify that the voltage between RT5 and Vss reads between 13 and 17V ac.
7. Turn the POWER switch to OFF and remove the Bus Interconnect and Monitor pcb and return the Isolator or Bus Interconnect to the instrument.
8. Reapply power to the 8500A.

Table 4-4. Power Supply Verifications

TEST POINTS		VOLTAGE RANGE (Vdc)		SUPPLY
HIGH	LOW	FROM	TO	
V_{DD}	V_{SS}	+ 11.4	+ 12.6	Logic
V_{GG}	V_{SS}	− 11.4	− 12.6	Logic
VA1	AR	+ 14.25	+ 15.75	Analog
VA2	AR	− 14.25	− 15.75	Analog
VA3	AR	+ 29.7	+ 31.7	Analog
VA4	AR	− 29.7	+ 31.7	Analog

4-43. DC Calibration Procedure

4-44. The offset adjustment, R14, in the Active Filter does not require adjustment unless Q27 or U5 have been replaced. There are no other adjustments in the Active Filter. Refer to troubleshooting, Figure 4-9, in this section for adjustment procedures for R14.

4-45. DC CONDITIONER ADJUSTMENTS

4-46. All adjustments and test points in the following procedures are on the DC Signal Conditioner. Perform the subtest, using the following procedure:

1. Select V DC, the 100 mV range, the slow filter (indicator on), the 2 readings per second sample rate, and the CAL switch ON (CAL indicator illuminated).
2. Short the 8500A input terminals.
3. Adjust R53 for a reading of 0 μV ±0 μV.
4. Remove the short from the input terminals and apply a 1 MΩ/0.22 μF parallel load.
5. Adjust R52 for a reading between −0.002 and +0.002V dc (0 ±2 μV).
6. Repeat steps 2 through 5 until both readings are present without an adjustment.

4-47. A/D CONVERTER CALIBRATION PROCEDURES

4-48. Use the following procedures to calibrate the A/D Converter. All test points and adjustments are on the A/D Converter.

4-49. This paragraph contains the adjustment procedure for R64. R64 requires adjustment only if R54 in the tens bit ladder has been replaced during repair. Unless R54 has been replaced, go on to the next paragraph.

1. Connect the test DMM HI to TP7, LO to TP6.
2. Adjust R1 for a test DMM reading of −7.000X V.
3. Remove the test DMM.
4. Using the test connections in Figure 4-1, apply 10.10000 volts dc to the 8500A input terminals.
5. Adjust R64 for an 8500A reading of +10.10000 ±5 cal digits.
6. Continue with the following adjustments.

4-50. A/D Zero Adjustment

1. Select the 10V range on the 8500A.
2. Short the 8500A input terminals.
3. Adjust R8 for a reading of 0.0000-0 ±1 cal digit.

4-51. A/D Calibrator Settings

4-52. Prepare the DC Voltage Standard for use during the A/D Calibration using the following procedure:

1. Connect the equipment, as shown with the solid lines in Figure 4-1. Do not connect the 8500A at this time.

2. Set the Voltage Divider controls at one-tenth the standard cell certified value (standard cell value x 0.1).

3. Adjust the DC Voltage Standard output for a null on the null meter.

4. Record the dial setting of the DC Voltage Standard as "Control Setting A." This setting will be used later in the procedure, in addition to the following paragraph.

5. Disconnect the leads at the Voltage Divider output terminals from the null meter and standard cell and connect the 8500A as shown with the broken lines in Figure 4-1.

4-53. A/D Ladder Adjustments

1. Select the 10V manual range on the 8500A.
2. Set the Voltage Divider controls for a ratio of 1.0100000.
3. Adjust R1 for a reading between +10.0999-9 and +10.1000-1 (+10.1000-0 ±1 cal digit).
4. Reverse the polarity of the dc voltage at the DC Voltage Standard for a negative input to the 8500A.
5. Adjust R2 for a reading between −10.0999-9 and −10.1000-1 (−10.1000-0 ±1 cal digit).
6. Return the polarity of the dc voltage to a positive output from the DC Voltage Standard input at the 8500A.
7. Set the Voltage Divider controls for a ratio of .0500000.
8. Adjust R7 for a reading between +0.4999-9 and +0.5000-1 (+0.5000-0 ±1 cal digit).
9. Repeat steps 2 through 8 until all readings are within tolerance without making an adjustment.
10. Set the Voltage Divider controls for ratio of .5100000.
11. Adjust R6 for a reading between +5.0999-9 and +5.1000-1 (+5.1000-0 ±1 cal digit).
12. Set the Voltage Divider controls for a ratio of .2600000.
13. Adjust R5 for a reading between +2.5999-9 and + 2.6000-1 (+2.6000-0 ±1 cal digit).
14. Set the Voltage Divider controls for a ratio of .1400000.
15. Adjust R4 for a reading between +1.3999-9 and +1.4000-1 (+1.4000-0 ±1 cal digit).
16. Set the Voltage Divider controls for a ratio of .0750000.
17. Adjust R3 for a reading between +0.7499-9 and 0.7500-1 (0.7500-0 ±1 cal digit).
18. Repeat steps 2 through 17 until all steps are within the stated tolerance.

4-54. Linearity Verification

1. Verify that the 8500A sample rate is set at two readings/second and the 10V manual range is selected.
2. Set the Voltage Divider controls for a ratio of .2000000.
3. Set the DC Voltage Standard for an output of approximately 100 volts and adjust its output for a reading between +19.9999-9 and +20.0000-1 on the 8500A.
4. Set the Voltage Divider controls for a ratio of .0000000 and verify that the reading is between −0.0000-1 and +0.0000-1 (0 ±1 cal digit).
5. Reverse the polarity of the dc voltage at the DC Voltage Standard for negative input to the 8500A.
6. Verify that the 8500A reads between −0.0000-1 and +0.0000-1 (0 ±1 cal digit).
7. Return the polarity of the dc voltage output from the DC Voltage Standard to a positive input at the 8500A.
8. Set the Voltage Divider controls to the settings listed in Table 4-5, verifying that the readings are within the tolerances listed in the table.
9. Reverse the polarity of the DC Voltage Standard output and repeat the steps in Table 4-5, checking that the reading is negative and within the listed tolerance.
10. Set the DC Voltage Standard for the "Control Setting A" recorded earlier.
11. Set the Voltage Divider controls for a ratio of 1.0000000.
12. Verify that the 8500A reads between +9.9999-9 and +10.0000-1 (+10.0000-0 ±1 cal digit).

Table 4-5. Linearity Checks

DIVIDER SETTING	READINGS		
	MINIMUM	NOMINAL	MAXIMUM
.0100000	0.9999-5	1.0000-0	1.0000-5
.0200000	1.9999-5	2.0000-0	2.0000-5
.0300000	2.9999-5	3.0000-0	3.0000-5
.0400000	3.9999-5	4.0000-0	4.0000-5
.0500000	4.9999-5	5.0000-0	5.0000-5
.0600000	5.9999-5	6.0000-0	6.0000-5
.0700000	6.9999-5	7.0000-0	7.0000-5
.0800000	7.9999-5	8.0000-0	8.0000-5
.0900000	8.9999-5	9.0000-0	9.0000-5
.1000000	9.9999-5	10.0000-0	10.0000-5
.1100000	10.9999-4	11.0000-0	11.0000-6
.1200000	11.9999-4	12.0000-0	12.0000-6
.1300000	12.9999-4	13.0000-0	13.0000-6
.1400000	13.9999-3	14.0000-0	14.0000-7
.1500000	14.9999-3	15.0000-0	15.0000-7
.1600000	15.9999-3	16.0000-0	16.0000-7
.1700000	16.9999-2	17.0000-0	17.0000-8
.1800000	17.9999-2	18.0000-0	18.0000-8
.1900000	18.9999-2	19.0000-0	19.0000-8
.2000000	19.9999-2	20.0000-0	20.0000-8

4-54. RANGE ADJUSTMENTS

4-56. All adjustments and test points in the following procedure are on the DC signal conditioner. Perform the subtests using the following procedures.

4-57. Perform the 100 mV range adjust as follows:

1. Ensure that the DC Voltage Standard is set for "Control Setting A."
2. Set the Voltage Divider controls for a ratio of .0000000.
3. Select the 100 mV range on the 8500A.
4. If required, readjust R53, for a reading of 0 ±0 μV.
5. Set the Voltage Divider controls for a ratio of .0300000.
6. Adjust R49 for a reading between +299.999 and +300.001 (+300.000 ±1 digit).

4-58. Perform the 1V range adjust as follows:

1. Select the 1V range on the 8500A.
2. Set the Voltage Divider controls for a ratio of .2500000.
3. Adjust R48 for a reading between +2.49999-9 and +2.50000-1 (+2.50000-0 ±1 cal digit).

4-59. Perform the 100V range adjust as follows:

1. Connect the equipment as shown in Figure 4-2.
2. Select the 100V range on the 8500A.
3. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 100 volts.
4. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null on the null meter.
5. Adjust R47 for a reading between +99.999-9 and 100.000-1 (+100.000-0 ±1 cal digit).

4-60. Perform the 1000V range adjust as follows:

1. Select the 1000V range on the 8500A and take the instrument out of the Cal mode by moving the CAL switch to OFF (CAL indicator extinguishes).
2. Verify that the 100 volt setting on the Reference Divider is still nulled.
3. The 8500A should read between +99.98 and +100.02 (+100.00 ±2 digits).
4. Set the Reference Divider input and output controls to 500 volts.
5. Set the DC Voltage Standard to approximately 500 volts, then adjust its output for a null on the null meter.
6. The 8500A should read between +499.98 and +500.02 (+500.00 ±2 digits).
7. Set the Reference Divider input and output controls to 1000 volts.
8. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null on the null meter.
9. The 8500A should read between +999.98 and +1000.02 (1000.00 ±2 digits).

4-61. TROUBLESHOOTING

⊗ CAUTION

Static discharge can damage components contained in the 8500A. To prevent this possibility, use the following precautions when troubleshooting and/or repairing the unit.

1. Never remove, install, or otherwise connect or disconnect modules and/or components without first turning the 8500A Power switch to OFF.
2. Perform all repairs at a static-free work station.
3. Do not handle IC's or pcb's by their connectors.
4. Use static ground straps to discharge repair personnel.

5. Use conductive foam to store replacement or removed IC's.

6. Remove all plastic, vinyl, and styrafoam products from the work area.

7. Use a grounded soldering iron.

4-62. A procedure for isolating faulty modules is contained in Table 4-6. It is important that the theory of operation given in Section 3 be read before attempting to troubleshoot the 8500A. The module isolation procedure involves making observations of the 8500A behavior, then removing or replacing modules to establish cause-effect relationships. DO NOT remove or replace modules with the power on. Follow the procedure step by step all the way through to assure that the fault is isolated to the correct module. Faults in some modules may cause apparent faults in other modules.

CAUTION

If the Isolator and the Bit Serial Asynchronous interface are installed, replacement of the Isolator by the Bus Interconnect Monitor pcb may allow a hazardous common mode voltage to appear on the output connector of the interface.

4-63. Figures 4-5 through 4-11 contain symptom analysis troubleshooting information for each of the modules and pcb's contained in the mainframe 8500A. The possible failures are listed in order of probability. Troubleshooting information for optional modules is contained in Section 6.

4-64. Troubleshooting Notes

4-65. By selecting the CAL mode, Error Codes are disabled. Any function may be selected and, if the module is not installed, random readings will be displayed.

4-66. In using the Bus Interconnect Monitor pcb, note that RT1 physically does not extend to the Isolator-Interconnect slot. RT1 is accessible with the Monitor pcb installed in any of the first four slots (J11A, B, C, or D). The outputs of the optional Ohms Converter and Current Shunts modules are on RT1.

4-67. DO NOT apply an input directly to the A/D Converter module. Damage to the A/D Converter may result. The DC Signal Conditioner may be bypassed by applying a signal directly to the Active Filter module, as outlined in the module isolation procedure.

4-68. Module Disassembly

4-69. All modules in the 8500A are mounted in shielded cases which may be disassembled, using the following procedure. Avoid using excessive force to prevent breaking the plastic.

1. Pop open the lid by using the indentations at either end and lifting up. Hinge the lid back.

2. Orient the module with one of the guides up.

3. Press down on the end of the case half above the words "OPEN" while pulling up lightly on the lip of the module guide and just separate that end.

4. Repeat step 3 for the other end.

5. Open the top of the module and the bottom catch will automatically come apart.

6. Press down on the top of the pcb while pulling out to free the pcb from the case half.

4-70. Use the following procedure for module reassembly.

1. Insert the pcb in the case half bottom first and lightly press down on the top to snap it in place.

2. Ensure that the spring shield connection is not caught behind the pcb.

3. Align the bottom center catch of the case halves, making sure the shields at either end fit together properly.

4. Close the two halves together, snapping the module guides closed.

5. Using a small screwdriver or similar tool, lift the spring shield connection so that it rests on the shield opposite.

4-71. Troubleshooting Aids

4-72. The Static Controller (MIS-7190K) and the Test Module (MIS-7191K) are valuable troubleshooting aids for the 8500A. Further information concerning these troubleshooting aids is available from any Sales Office. Troubleshooting procedures using the Static Controller and the Test Module will be included with the modules.

Table 4-6. Faulty Module Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1.	Turn the power ON. The following should be displayed. HI 1.0.Y (Y=Program number) then C XXXXX (X = installed option number) then 0.00 ±.05 (DC Volts, 1000V range, Fast sample rate)		
2.	Is the display blank?	6	3
3.	Is the initial display other than HI 1.0.0?	42	4
4.	Is the reading other than 0.00 ±.05	59	5
5.	Are the first three displays normal?	78	2
	DISPLAY BLANK AT POWER ON		
6.	Remove bus interconnect (or Isolator if installed).		
7.	Turn power ON. Is HI 1.0.0 displayed?	8	11
8.	Was the isolator installed?	9	11
9.	Install interconnect-monitor in the Isolator slot. Is HI 1.0.0 displayed?	10	13
10.	Bad Isolator. Go to Section 6 under Isolator.		
11.	Is the power indicator on?	17	12
12.	Check the fuse. Is it bad (replace)?	1	17
13.	Remove Cal Memory and remote interfaces if installed. Is HI 1.0.0 displayed?	14	17
14.	Replace Cal Memory. Is HI 1.0.0 displayed?	16	15
15.	Bad Cal Memory. Go to Section 6 under Calibration Memory.		
16.	Bad Remote Interface. Go to Section 6 under the appropriate interface.		
17.	Install the interconnect-monitor PCB in the Isolator slot.		
18.	Check power supply voltages as follows. Test DMM Common to VSS. V_{DD} = +11.4 to +12.6 V_{CC} = +5.15 to 5.25 V_{GG} = −11.4 to −12.6 LINE = 13V ac to 17V ac		
19.	Are the power supplies within tolerance?	26	20
20.	Remove all modules except the Front Panel.		
21.	Recheck power supplies. Within tolerance?	22	23
22.	Replace modules one at a time (start with Controller), rechecking supplies after replacing each module. The last one put in when the supplies go bad is the rotten egg. Go to the appropriate figure for that module.		
23.	Remove the front panel. Recheck supplies. Within tolerance?	25	24
24.	Problem on power supply, motherboard, or power supply interconnect.		
25.	Bad Front Panel. Go to Figure 4-7.		

Table 4-6. Faulty Module Isolation (Continued)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
26.	Remove Cal Memory and the remote interface if installed.		
27.	Check IC 6, 5, 1, 0 on interbus. All moving?	28	30
28.	Check ACK line. Moving?	29	30
29.	Check ID0 –7. All moving?	32	30
30.	Check Controller clock, TP2, TP3 (TP1 = gnd). Is 12V, 1.7 MHz signal present?	33	31
31.	Bad Controller. Go to Figure 4-6.		
32.	Bad Front Panel. Go to Figure 4-7.		
33.	Remove analog modules, leaving only Controller, Front Panel, and Interconnect. Is the display normal?	34	35
34.	Faulty Analog Module. Replace one at a time – last one in is the rotten egg. Go to the appropriate figure for that module		
35.	Remove Front Panel, replace DC Signal Conditioner, Filter, A/D Converter.		
36.	Check IC lines, ACK line, ID lines. All moving?	38	37
37.	Bad Controller. Go to Figure 4-6.		
38.	Bad Front Panel. Go to Figure 4-7.		
	INITIAL DISPLAY OTHER THAN HI 1.0.0		
39.	Remove Interconnect PCB (or Isolator if installed).		
40.	Apply power. Is the display as follows? HI 1.0.0 C XXXXX Error 9	41	44
41.	Was the Isolator installed?	42	47
42.	Install Interconnect-monitor PCB in Isolator slot. Is display normal?	43	48
43.	Bad Isolator. Go to Section 6.		
44.	Are Cal Memory or remote interface installed?	45	47
45.	Remove Cal Memory and remote. Display normal?	46	47
46.	Replace one at a time. Last one in is the rotten egg. Go to appropriate figure.		
47	Install Interconnect-Monitor PCB.		
48.	Check for shorts between the IC and the ID lines. Shorts?	49	51
49.	Remove all modules except Front Panel. Removed short?	50	57
50.	Reinstall modules one at a time (start with Controller), checking for shorts between modules. Last one in is the rotten egg. Go to the figure for the appropriate module.		

Table 4-6. Faulty Module Isolation (Continued)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
51.	Are any of the IC, ID, or ACK lines always high or always low?	53	52
52.	Remove all modules except Front Panel and Controller. IC and ID moving?	56	53
53.	Remove Front Panel. Reinstall dc analog modules if removed.		
54.	Are the IC, ID, and ACK lines moving?	57	55
55.	Bad Controller. Go to Figure 4-6.		
56.	Is the display normal?	58	57
57.	Front Panel bad. Go to Figure 4-7.		
58.	Faulty Analog module. Replace one at a time until symptoms recur. Last one in is faulty. Go to the figure for the appropriate module		
	READING NOT ZERO AT TURN ON		
59.	Remove all optional modules (except Isolator if installed), leaving Controller, (Isolator), DC Signal Conditioner, Filter, A/D, Front Panel.		
60.	Apply power. Is the reading zero?	61	62
61.	Replace modules one at a time until reading is not zero. Last one in is the rotten egg. Go to Section 6.		
62.	Is the Isolator installed?	63	65
63.	Replace Isolator with Interconnect-Monitor PCB. Is the reading zero?	64	65
64.	Bad Isolator. Go to Section 6.		
65.	Install Interconnect Monitor if not already installed. Check supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to +15.75 V VA4 = −29 to −32 V VA2 = −14.25 to −15.75V V_{CC} = −15V } Difference must equal VA3 = +29 to +32V V_{SS} = −20V } 4.9 to 5.2V		
66.	Supply voltages in tolerance?	70	67
67.	Remove all modules except Front Panel. Supplies in tolerance?	69	68
68.	Repair power supply. Go to Figure 4-5.		
69.	Replace modules one at a time, checking supplies between modules. Last one in is faulty. Go to the appropriate figure.		
70.	Remove Filter module. CAL switch on. Select DC Volts, 1000V range.		
71.	Is the reading zero?	72	77
72.	Replace Filter module; remove DC Signal Conditioner.		
73.	Place a jumber (short) between RT2 and RT6.		
74.	Is the reading zero (disregarding CAL digit)?	75	76

Table 4-6. Faulty Module Isolation (Continued)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
75.	DC Signal Conditioner bad. Go to Figure 4-8.		
76.	Filter module bad. Go to Figure 4-9.		
77.	A/D converter bad. Go to Figure 4-10.		
78.	Do the Performance Tests earlier in this section.		
79.	Is the unit within the tolerances given?		80
80.	Is the Cal Memory installed?	81	83
81.	Remove the Cal Memory. Is the unit now within tolerance?	82	83
82.	Faulty Cal Memory. Go to Section 6.		
83.	Is the Isolator installed?	84	87
84.	Replace Isolator with Interconnect-monitor PCB.		
85.	Is unit within tolerance?	86	87
86.	Bad Isolator. Go to Section 6.		
87.	Is the failure in DC Volts Performance Test?	89	88
88.	Go to Section 6 for the appropriate faulty function.		
89.	Remove all optional modules, leaving Front Panel, Controller, DC Signal Conditioner, Active Filter, and A/D Converter.		
90.	Do the DC Volts Performance Test. Is the unit within tolerance?	91	92
91.	Reinstall options one at a time, rechecking DC Volts tolerance. Last module installed when unit becomes out of tolerance is faulty. Go to Section 6.		
92.	Check supply voltages according to the following chart. VA1 = +14.25 to +15.75V VA4 = −29 to −32V VA2 = −14.25 to −15.75V V_{CC} = −15V) VA3 = +29 to +32V V_{SS} = −20V) Difference = 4.9 to 5.2V		
93.	Are the supplies within tolerance?	97	94
94.	Remove all modules except Controller and Front Panel. Are the voltages correct?	95	96
95.	Replace modules one at a time until the voltages go bad. Last one in is the rotten egg. Go to the appropriate figure.		
96.	Repair power supply. Go to Figure 4-5.		

Table 4-6. Faulty Module Isolation (Concluded)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
97.	Connect the test DMM LO to RT2 and HI to RT6. Apply known voltages to the 8500A input to test the DC Signal Conditioner. The following voltages are suggested inputs:		
	8500A RANGE / GAIN DC SIG COND / INPUT / TEST DMM READING		
	100mV / X64 / 2mV / 128.0mV		
	100mV / X64 / 200 mV / 12.80V		
	1V / X8 / 125mV / 1.0V		
	1V / X8 / 2V / 16.0V		
	10V / X1 / 1V / 1.0V		
	10V / X1 / 19V / 19.0V		
	100V / ÷8 / 1V / 125.0mV		
	100V / ÷8 / 140V / 17.50V		
	1000V / ÷64 / 64V / 1.0V		
	1000V / ÷64 / 960V / 15.0V		
98.	Are the readings correct (noise or drift in the DC Signal Conditioner will show up on the Test DMM readings)?	100	99
99.	DC Signal Conditioner faulty. Go to Figure 4-8.		
100.	Connect Test DMM HI to RT5. Repeat table in step 97. The test DMM readings should be the same.		
101.	Are the Test DMM readings the same?	103	102
102.	Faulty Active Filter module. Go to Figure 4-9.		
103.	Faulty A/D Converter. Go to Figure 4-10.		

SYMPTOM	POSSIBLE FAILURE
GUARDED SUPPLY	
VA1 – BAD	U3, BR2, or Transformer
(+15V). Noisy	C3, BR2
VA2 – BAD	U4, BR2, or Transformer
(–15V) Noisy	C4, BR2
VA3 – BAD	U2, CR4, BR1, Transformer
(+30V) Noisy	C2, BR1
VA4 – BAD	U1, CR3, BR1, Transformer
(–30V) Noisy	C1, BR2
V_{CC} (Guarded)	U5, R5, R3, C5, CR1, CR2, Transformer

VA1 and VA2 are used as a reference for VA3 and VA4. VA3 and VA4 could load down VA1 and VA2. Check by lifting the reference diodes CR3 and CR4.

UNGUARDED SUPPLY	
V_{DD} (+12V)	U6, C6, C9, C12, BR3, Transformer
V_{GG} (–12V)	U7, C13, C10, C7, BR3, Transformer
V_{CC} (+5V)	U8, R6, R4, C8, C13, C11, BR4, Transformer

The drawing below identifies the pins at the power supply edge connector. Input voltages to the regulators should be approximately 5V higher than the normal output voltages. If the output is higher or lower than specified and noise is not the problem, the regulator is bad.

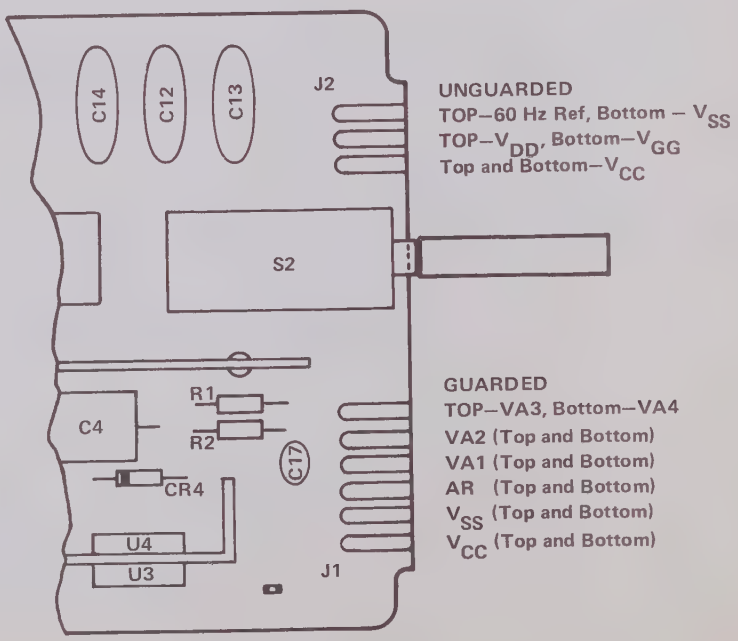


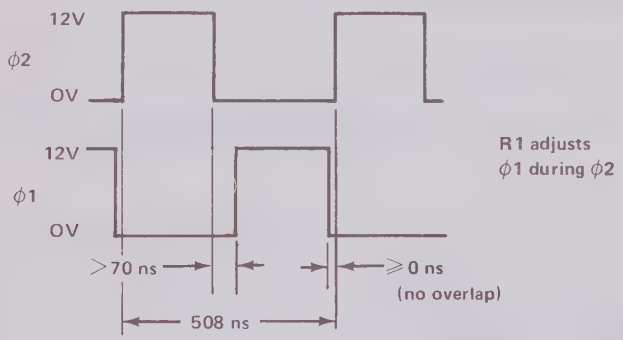
Figure 4-5. Power Supply Troubleshooting

NOTE

Due to the speed and complexity of the controller, it is recommended that, when a problem is isolated to the controller, the unit be sent to the nearest Service Center for repair. The following information will assist in troubleshooting simpler problems. Many problems require the use of a Trendar or similar tester.

SYMPTOM	POSSIBLE FAILURE
Troubleshoot the Controller with only the Controller, Front Panel, and Power Supply installed.	
Blank Display (most common symptom of controller failure)	Proceed with checks listed below

1. Check $\phi 1$ and $\phi 2$ clock at TP2, TP3



$\phi 1$ bad, $\phi 2$ ok	U3, U9, U10
$\phi 1$ ok, $\phi 2$ bad	U9, U10
$\phi 1$, $\phi 2$ bad	U3, U9, Y1
$\phi 1$ won't adjust	R1, U3, U9, capacitors

2. Check RST 9reset) line (at U10-12, U35-13)

   High? Check for 400 μsec delay on +5V at U36-13

   Stuck Low? U35, U34, U36, U38

3. Check RDT (ready) line (at U10-23, U1-9)

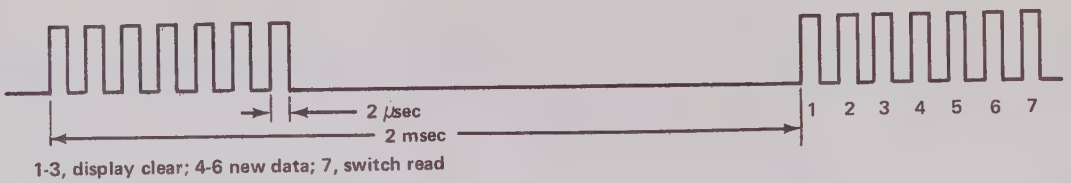
   Pulsing – OK

   Always low . . . . . clock pulse at U1-12 U1, U16, U15, U8– check inputs to U8, U18

   Always high . . . . . ACK interrupt or mark interrupt not functioning properly

Figure 4-6. Controller Troubleshooting

SYMPTOM	POSSIBLE FAILURE
4. Check Bus ACK Signal.	



1-3, display clear; 4-6 new data; 7, switch read

No pulses on ACK line	Mark interrupt circuit (U14-12, U37-3) Phase lock loop (pulses every 2 msec) IC lines output enable (U17-10) IC lines output gates (U29, U37)
ACK always high	U38, CR1, C27
5. Check IB OUT (U17-9) — is data going out?	
6. Check A15, WAIT, WR, and DBIN lines	U10, ROM enable, ROM decoders, ROM
7. Check address and data lines at U10 for being held high or low all the time.	
8. If MARKS, INT, INTE OK, INT VECTOR (U28, U19, U37) may be bad giving wrong vector information.	

OTHER PROBLEMS

Won't read switches	IC6 bad (no ACK) or bad data in
Displays all modules present (CXXXXX)	ACK INT CKT, ACK held high
Wrong display	Data bad, IC line always high
Won't respond to external interrupts	U17 (INT), U37, U32 (INA) U28, U19, U23 (INT Vector wrong)

Figure 4-6. Controller Troubleshooting (Concluded)

SYMPTOM	POSSIBLE FAILURE
No ACK Pulse	U28, U19 (Address Decoders) U23 (Indirect F/F) U19, U11, Q10 (ACK Circuit)
No Display (ACK Pulse Present)	U18 (Kill Circuit)
No Response to Switch Pushes (Display Good)	Switch Associated With Function U32, CR1 – CR4 Open
Segment Bad In All LEDs	Check Path from Latch to Transistor Drivers to LED Cathodes
One LED Doesn't Light	Check Path From Latch To Inverter to Transistor Drivers to LED Anode
Segment or Decimal Missing On Only One LED	Bad LED
Display Gives Wrong Numbers, One LED Brighter	U11 (Reset to Indirect Address F/F, U23) Address Decoder. (Problem is Indicative of Front Panel Responding to an Invalid Address.)

Figure 4-7. Front Panel Troubleshooting

SYMPTOM	POSSIBLE FAILURE
DC Inoperative All Ranges	Digital Control Logic Q8, Q6, Q7, Open K1, Q1, Q2 Open; Q18, Q19, U3 Bad
Display Blanks	U1 or U2
Locks in Overrange	U3
Reading Drifts	U4; Q14, Q15, Q16 Leaky
Won't Zero	U5 or U6
100 mV Range Bad	Q31, Q32, Q14
1V and 100V Range Bad	Q33, Q34, Q15
100V and 1000V Range Bad	K2, Q3, Q4
Random Readings	K1 Open, K2 Shorted
Nonlinear Readings	Q16, Q15, Q14 Leaky

ADDRESS AND DATA FIELD

ADDRESS	IB DATA DURING ADDRESS				
IC4, IC3, IC0 = 1	**ID3**	**ID2**	**ID1**	**ID0**	
	0	1	1	0	100 mV Range G = 64
	1	0	1	0	1V Range G = 8
	1	1	0	1	10V Range G = 1
	1	0	0	0	100V Range G = ÷8 (÷64 x 8)
	1	1	0	0	100V Range G = ÷64

ID3 - ID4 = Control Amplifier Gain

0 1 = x 64
1 0 = x 8
1 1 = z 1

RT1 inputs controlled as follows for OHMS & ADC

ADDRESS	DATA				
	ID3	**ID2**	**ID1**	**ID0**	
IC4, IC3, IC0 = 1	0	1	0	1	G = x 64
	1	0	0	1	G = x 8
	1	1	0	1	G = x 1

NOTE

If R54–R57, Q18, Q19 or Q22 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-8. DC Signal Conditioner Troubleshooting

SYMPTOM	POSSIBLE FAILURE
High Zero Offset	Q32, Q25, Q19, Q20 Shorted
DC Inoperative	Q18 Open – Q21, Q22, Q23, Q24 Open Q27, U5 Digital Logic
Overrange	U5 – Q19, Q20 Shorted
Noisy	
All Ranges	
Either Filter	Q25, Q32 Leaky – Q31, U5 Bad
Slow Filter (ON)	Q21, Q22 Leaky – U4 Bad
Fast Filter (OFF)	Q23, Q24 Leaky – U3 Bad
Nonlinear Readings	U5
Display Blanks	U1 Or U2

ADDRESS AND DATA FIELD

ADDRESS	DATA
IC4, IC3, & IC1 = 1	ID0 = 1 Filter By Pass (Remote Only) ID1 = 1 Z Filter (F.P. Light On) ID2 = 1 Y Filter (F.P. Light Off) ID3 = 1 Filter - Always on except In Ext. Ref. ID4 = 1 Ext. Ref. Lo ID5 = 1 Ext. Ref. Hi

Adjustment of R14

1. Short the 8500A input terminals.
2. Short RT6 to RT2 on the Bus Interconnect Monitor.
3. Adjust R14 for a reading of $\pm$.000000 $\pm$2 digits. (This requires that the A/D Converter is working accurately.)

Selection of R15 or R16.

If Q27 or U5 have been replaced, R15 and R16 will require reselection if adjustment of R14 does not zero the reading.

1. Only one of R15 and R16 will be installed. Replace whichever is installed with a short.
2. Connect the R15 short to the R16 short.
3. Short RT6 to RT2 on the Bus Interconnect Monitor.
4. Connect the test DMM HI to TP3 and LO to TP1 on the Active Filter module.
5. Select a resistor from the table below according to the measured offset. If the polarity is positive, install the resistor as R16; if negative as R15. (Maximum allowable offset in this step is 5200 μV.)

OFFSET (μV)	RESISTOR	JOHN FLUKE PART NO.
0-400	None	
401-1200	31.6K	261610
1201-2000	63.4K	235382
2001-2800	97.6K	241380
2801-3600	133.0K	289074
3601-4400	165.0K	376186
4401-5200	205.0K	375931

6. After installing the resistor, adjust R14.

Figure 4-9. Active Filter Troubleshooting

DIGITAL BOARD

SYMPTOM	POSSIBLE FAILURE
Display Blanks	U33, U34, U35 (Affecting ID Lines)
Improper Readings, Inoperative A/D, Nonlinear Readings	Check Transistor Array Outputs to J1 and J2 — The Rise and Fall Times of These Switching Pulses Must be <2 μsec.
Flickering Display	Autozero Control — U25, U34
Direct Address	
IC 4, 3, & 2 High	ID0 = 1 = Reset Counter ID1 = 1 = Auto Zero ID2 = 0 = Buffer Input ID2 = 1 = Remainder Input ID3 = 1 = Channel X (Auto Zero and Remainders 1 and 3) ID3 = 0 = Channel Y (Remainders 2 and 4)
Indirect Address	
IC 2 & 1 High (and Ring Counter Not in C0 Time period, C0 = 0)	This Indirect Address allows the ID7 Enable to bring back Polarity Bits to the Controller Module

ANALOG BOARD

First Check TP5 — Should be switching between + and —7V. Typical failures in this circuit result in a portion of the switching slope having a slew rate less than 1V/μsec. A glitch at the zero point is normal.

SYMPTOM	POSSIBLE FAILURE
Noisy Readings	U1, U2, U3
Nonlinear Ladder	U4, Q9, Q10 (Q27)
Ladder Out Of Tolerance	FETS Q11 — Q15 or Q17 — Q21
All Digits Wrong	U7, Q31, Q32
Reading Locked (Doesn't Respond To Input Change) Or Always Overrange	U4, Q9, U1, U2, U3, Q2, Q3
Bad Remainders (Lesser Digits)	Q22, U4, U6
No Polarity Bit Returned	Q29, Q28
Shifty Readings (Most Or All Digits)	Autozero Settling Time Problems U8, Q30 — Q8, Q7

NOTE

If U1, R9, R14-R16, R34, R35, R50-55, R67, Q1-Q3, Q11-Q16, Q25, or Q26 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-10. R² A/D Converter Troubleshooting

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

	ASSEMBLY NAME/NUMBER	PART NO.	PAGE
A1	Final Assembly	8500A	5-3
A2	Motherboard PCB Assembly	459628	5-8
A3	Bus Interconnect PCB Assembly	459636	5-11
A4	Power Supply Assembly	448860	5-13
A5	Power Supply Interconnect	410760	5-15
A6	Controller PCB Assembly	384107	5-16
A7	Front Panel-Display Assembly		5-20
A8	D.C. Signal Conditioner Assembly (MIS-4100)	383901	5-24
A9	Active Filter Assembly	383745	5-28
A10	Fast R^2 A/D Converter Assembly		5-31

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the mainframe instrument. A parts breakdown for each of the optional modules is contained in the subsection of Section 6 pertaining to the module. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation or Item Number.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)
5. Manufacturer's Part Number or Type.
6. Total Quantity per assembly or component.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.
8. Use Code is provided to identify certain parts that have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation or Item Number.
5. Printed Circuit Board Part Number.
6. Instrument Model and Serial Number.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY

⊗ CAUTION

Indicated devices are subject to damage by static discharge.

A1 FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	**FINAL ASSEMBLY 15 INCH PACKAGE MODEL 8500A Figure: 5-1**	8500A	89536	8500A			
A2	Mother Board PCB Assembly tested (8500A-4001T) Figure: 5-2	459628	89536	459628	1		
A3	Bus Interconnect PCB Assembly (MIS-4081) Figure: 5-3	459636	89536	459636	1		
A4	Power Supply PCB Assembly tested (8500A-4031T) Figure: 5-4	448860	89536	448860	1		
A5	Power Supply Interconnect PCB Assembly (8500A-4032) See Figure 5-1	401760	89536	401760	1		
A6	⊗ Controller PCB Assembly tested (MIS-4185T) Figure: 5-5	384107	89536	384107	1		
A7	⊗ Front Panel Display PCB Assembly tested (8500A-4021T) Figure: 5-6	384032	89536	384032	1		
A8	⊗ DC Signal Conditioner PCB Assembly (MIS-4100T) Figure: 5-7	383901	89536	383901	1		
A9	⊗ Active Filter PCB Assembly (MIS-4130T) Figure: 5-8	383745	89536	383745	1		
A10	⊗ Fast R^2 A/D Converter PCB Assembly (MIS-4140T) Figure: 5-9 & 5-10	383984	89536	383984	1		
1	Bail, full width	231407	89536	231407	1		
2	Bezel, I/O	416206	89536	416206	1		
3	Button, pwr switch	401646	89536	401646	1		
4	Chassis Assy	383414	89536	383414	1		
5	Chassis Insulator	433938	89536	433938	1		
6	Channel, rubber	103622	83478	896	5		
7	Contact strip	370619	30817	97-500-A	.75 in.		
8	Corner, finished	349993	89536	349993	2		
9	Corner, handle	350009	89536	350009	2		
10	Cover, bottom	383265	89536	383265	1		
11	Cover, plate, rear input	420679	89536	429679	1		

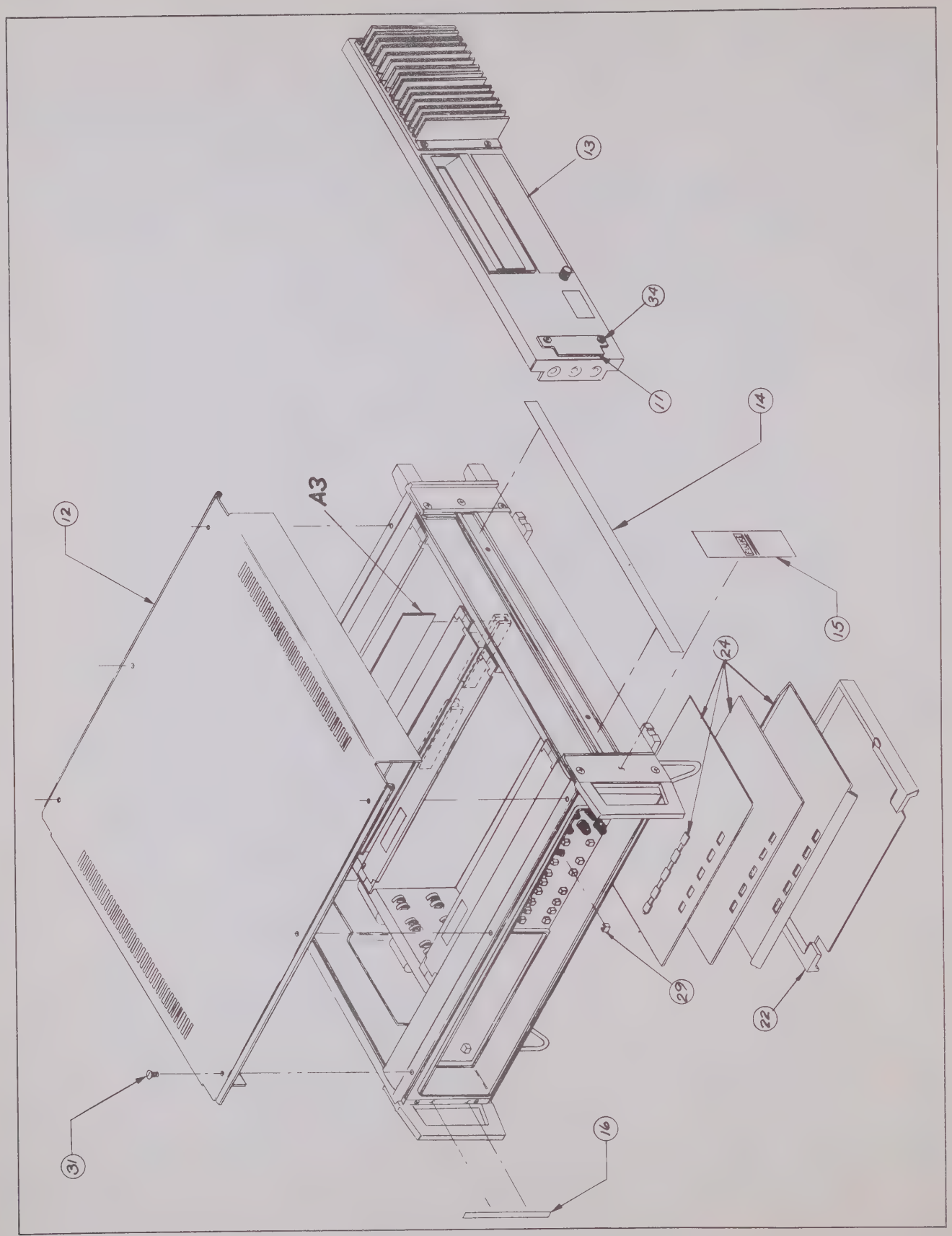


Figure 5-1. A1 Final Assembly (8500A) (Sheet 1 of 2)

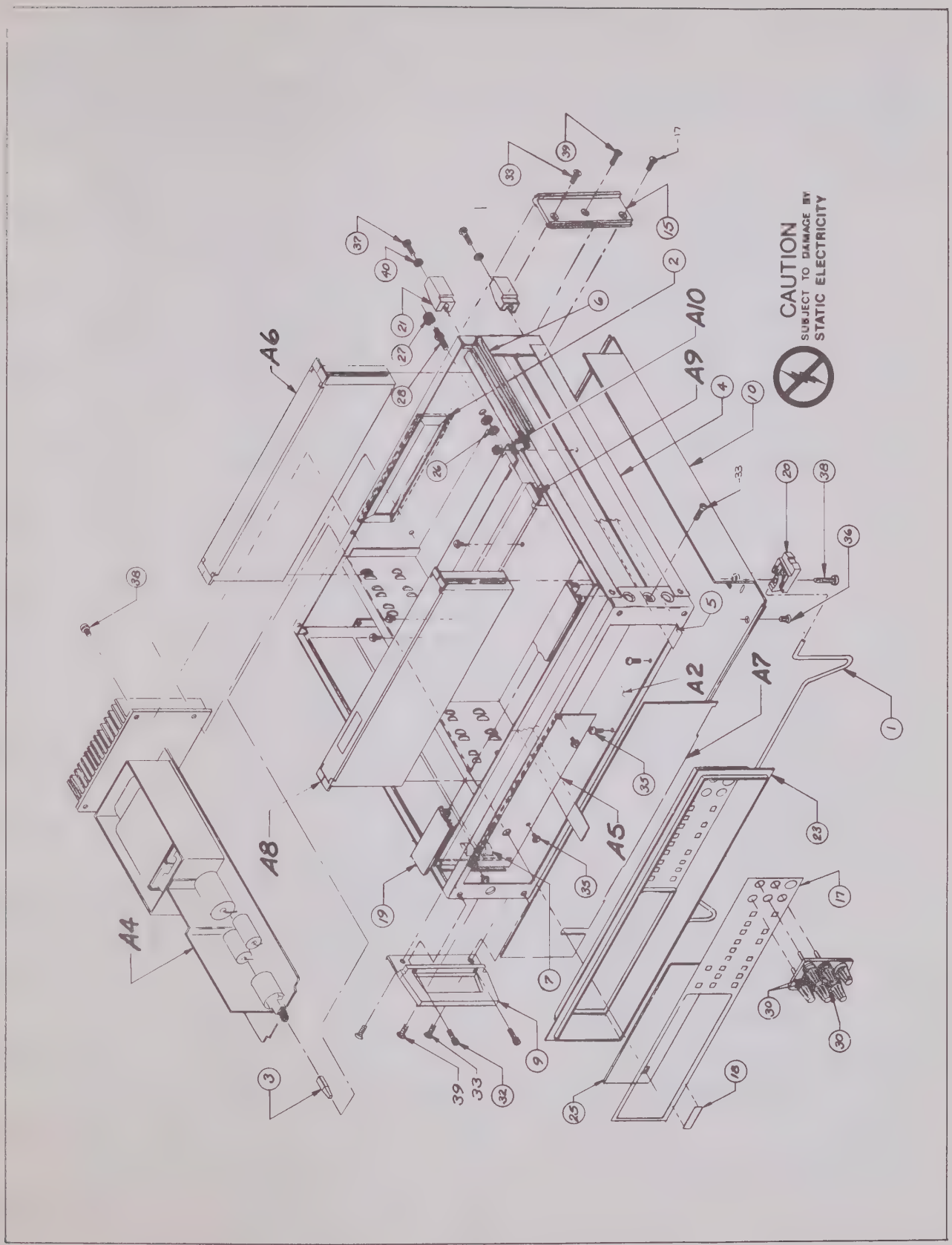


Figure 5-1. A1 Final Assembly (8500A-5001) (Sheet 2 of 2)

A1 FINAL ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
12	Cover, top	383257	89536	383257	1		
13	Decal, rear panel	413369	89536	413369	1		
14	Decal, side trim, fwd	295386	89536	295386	1		
15	Decal, corner	350405	89536	350405	4		
16	Decal, handle trim	436832	89536	436832	2		
17	Decal, front panel	413351	89536	413351	1		
18	Decal, serial no.	393957	89536	393957	1		
19	Extrusion, PCB retainer	408476	89536	408476	1		
20	Foot, bail stand	292870	89536	292870	4		
21	Foot, rear panel	307363	89536	307363	2		
22	Holder, instruction book	427534	89536	427534	1		
23	Insert, front panel	381871	89536	381871	1		
24	Instruction Page Assy	444049	89536	444049	1		
25	Lens display	383380	89536	383380	1		
26	Nut, hex, double chamfer, 1/4 – 28	110619	89536	110619	1		
27	Post, binding, head grnding	225615	20584	3575	1		
28	Post, binding, grnding	225623	20584	3576	1		
29	Plug, switch	437855	89536	437855	1		
30	Shorting link	190728	83330	21171	3		
31	Screw, FH undercut, 6 – 32 x 1/4	320093	89536	320093	6		
32	Screw, cap, lo head socket #8	295105	74445	8-32UNRC	4		
33	Screw, FHP, countersunk	114116	73734	20264	8		
34	Screw, PHP, sems, 6 – 32 x 3/8	177022	89536	177022	2		
35	Screw, PHP, 4-40 x 1/4	129882	73734	19022	11		
36	Screw, FH, undercut, 6 – 32 x 1/4	320093	89536	320093	6		

A1 FINAL ASSEMBLY (Conclusion)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
37	Screw, PNA, 8 – 32 x 5/8	293324	73734	23067	2		
38	Screw, PHP, sems, 6 – 32 x 1/2	177030	89536	177030	8		
39	Screw, FHP, countersink 8 – 32 x 1/2	114355	73734	18266	4		
40	Washer, lock, int tooth, #8	110320	73734	1305	2		
41	Washer, lock, int tooth, #1/4	110817	73734	1308	1		

A2 MOTHERBOARD PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	**MOTHERBOARD PCB ASSEMBLY** **8500A-4001 Figure: 5-2**	459628	89536	459628	REF		
J2	Connector, bd edge recpt, 18 pin	291906	00779	583650-3	1		
J6	Connector, bd edge recpt, 20 pin	291914	00779	583650-4	1		
J7	Connector, bd edge recpt, 8 pin	354951	00779	583407-5	1		
J8, J28, J31A thru J31D	Connector, bd edge recpt, 4 pin	417550	89536	417550	6		
J11A thru J11D, J21G, J22H, J23H, J29K, J30K, J31L, J31M, J31N	Connector, bd edge recpt, 40 pin	422550	00779	2-583407-0	12		
J12A, J12B, J12C, J12D	Connector, bd edge recpt, 6 pin	291625	00779	583650-1	4		
J27	Connector, bd edge recpt, 10 pin	403964	00779	583407-6	1		
J41	Binding post, blk	275560	32767	820-45	1		
J42	Binding post, red	275552	32767	820-65	1		
R1, R2	Res, mtl film 30.9 ±1%, 1/2W	247569	91637	MFF1-23092F	2		
R3	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	1		
R4	Res, comp, 5.6M ±5%, 2W	169821	01121	HB5655	1		
XJ2, XJ6, XJ11A, thru XJ11D, XJ21G, XJ22H, XJ23H, XJ27, XJ29K, XJ31L XJ31M, XJ31N	Polarizing insert	293498	00779	530030-1	14		

A3 BUS INTERCONNECT PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	**BUS INTERCONNECT PCB ASSEMBLY (MIS-4081) Figure: 5-3**	459636	89536	459636	REF		
C1, C2	Cap, Ta, 220 μf $\pm$20%, 6V	408682	56289	196D227X-0006TE4	2		
CR1	Diode, si, rect, 1 amp	343491	01295	1N4002	1		

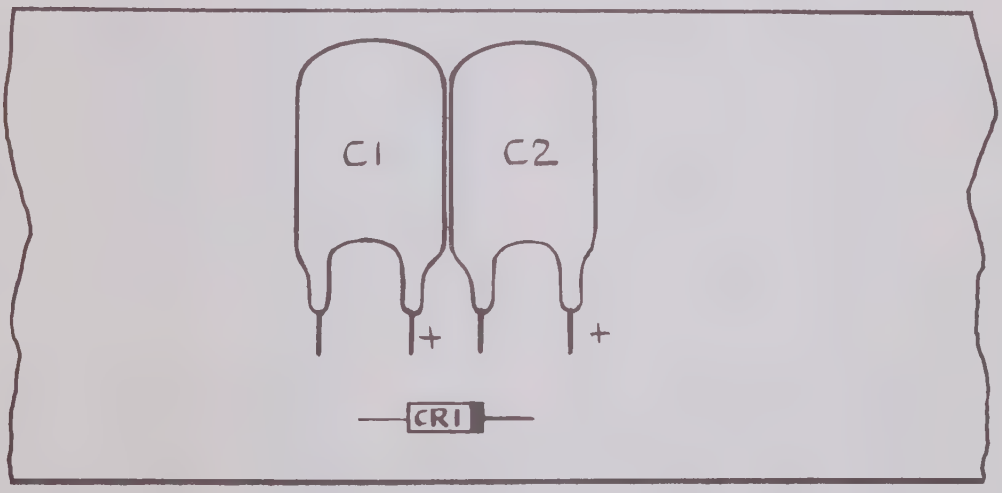


Figure 5-3. A3 Bus Interconnect PCB Assembly

A4 POWER SUPPLY ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	**POWER SUPPLY ASSEMBLY 115/230V Figure: 5-4**	448860	89536	448860	REF		
A4	**POWER SUPPLY ASSEMBLY 100V Figure: 5-4**	456988	89536	456988	REF		
BR1, BR2, BR3, BR4	Bridge, Rectifier	296509	09423	FB200	4	1	
C1, C2	Cap, elect, 470 μF −10/+50%, 40V	185868	73445	ET471X040-A02	2	1	
C3, C4	Cap, elect, 220 μF −10/+50%, 40V	178616	73445	ET221X040-A01	2	1	
C5, C7	Cap, elect, 2200 μF −10/+100%, 25V	448126	12674	61C25BAS-252	2	1	
C6	Cap, elect, 4000 μF −10/+100%, 25V	370734	12674	61C25TS43	1	1	
C8	Cap, elect, 15000 μF −10/+100%, 15V	407940	12674	61C15HA153	1	1	
C9, C10 C11, C17	Cap, Ta, 5.6 μF ±20%, 25V	368969	56289	196D565X-0025KA1	4		
C12, C13, C14	Cap, cer, 0.1 μF ±20%, 100V	149146	56289	33C41B6	3		
C15, C16	Cap, cer, 0.005 ±20%, 3 kV	188003	71590	2DDH6R502M	2		
CR1, CR2, CR5	Diode, Rect, Si, 50V	347559	05277	1N5400	3	1	
CR3, CR4	Diode, Rect, Si, 100V	343491	01295	1N4002	2	1	
F1	Fuse, slo-blo, 1/2 amp	109322	71400	MDL1-2	1	5	
R1, R2	Res, comp, 3.3k ±5%, 1/4W	148056	01121	CB3325	2		
R3, R4	Res, comp. 490 ±5%, 1/4W	147975	01121	CB3915	2		
R5, R6	Res, var, cermet, 50 ±20%, 1/2W	320861	02111	62-1-1-500	2	1	
S1	Switch, slide, dpdt (115/230V)	376798	82389	11A1437	1	1	
S2	Switch, power	291526	89536	291526	1	1	
T1	Xfmr, Header Assy (115/230V)	450403	89536	450403	1		
T1	Xfmr, Header Assy (100V)	456350	89536	456350	1		
U1, U3	IC, lin, vol reg	413187	04713	MC7815CP	2	1	

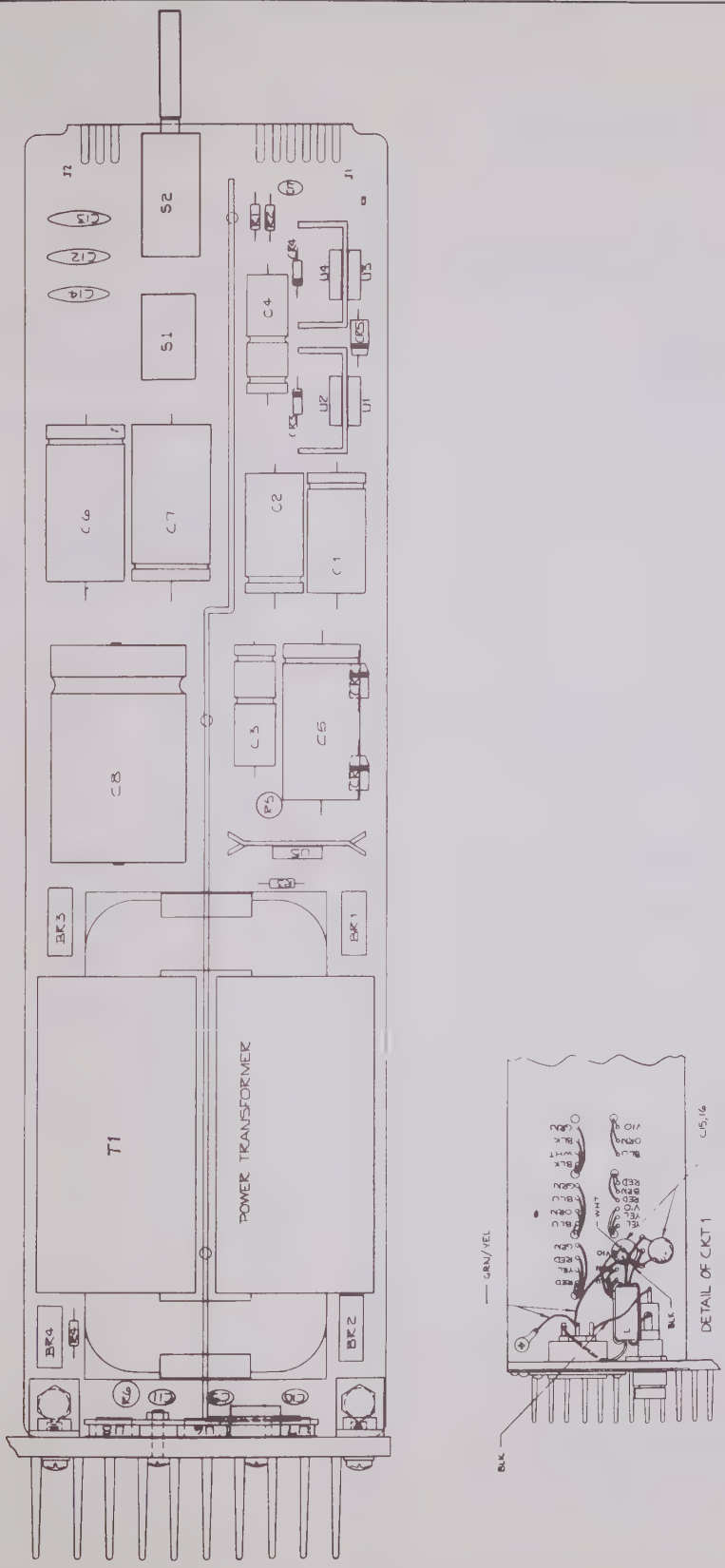


Figure 5-4. A4, Power Supply PCB Assembly

A5 POWER SUPPLY ASSEMBLY (Conclusion)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U2, U4	IC, lin, neg, vol reg	413179	04713	MC7915CP	2	1	
U5	IC, lin, vol reg	355107	04713	MC7805CP	1	1	
U6	IC, lin, vol reg	428854	04713	MC7812CP	1	1	
U7	IC, lin, neg, vol reg	381665	04713	MC7912CP	1	1	
U8	IC, lin, vol reg	428847	04713	MC7805CP	1	1	
XF1	Fuseholder	435628	89536	435628	1		
	Connector, pwr, recpt	284166	82389	EAC301	1		
1	Decal	386250	89536	386250	1		
	Extrusion	416974	89536	416974	1		
	Ferrite, Core	420588	89536	429588	1		
	Heat Dissipator (use with U1, U2, U3, U4)	414128	13103	6030B-TT	2		
	Heatsink (use with U5)	386235	13103	6032D	1		
	Insulator, power switch	383153	89536	383153	1		
	Insulator, semiconductor mtg	428821	55285	7403-10-51	5		
	Insulator Gasket	436824	89536	436824	1		
	Nutplate	420448	89536	420448	1		
	Socket, IC, (use with U6, U7, U8)	402958	27264	10-18-2031	3		
1	The following items not shown.						

A5 POWER SUPPLY INTERCONNECT ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	**POWER SUPPLY INTERCONNECT ASSEMBLY 8500A-4032**	401760	89536	401760	REF		
P1	Connector, bd edge, recpt	291625	00779	583650-1	1		
P2	Connector, bd edge, recpt	352682	00779	583694-2	1		
	NOTE: *See figure 5-1 (sheet 2 of 2) for location. Not Illustrated separately.*						

A6/A6A1 CONTROLLER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6 Ⓧ	**CONTROLLER ASSEMBLY, TESTED MODULE 8500A-4185T** **Figure: 5-5**	384107	89536	384107	REF		
U7	IC, dgtl, MOS, N-channel, Si-gate	428813	89536	428813	1	1	
U10	IC, dgtl, MOS, N-channel, Si-gate CPU, 8-bit parallel	404541	01295	TMS8080	1	1	
U22	IC, dgtl, MOS, N-channel, Si-gate	418422	89536	418422	1	1	
U25	IC, dgtl, MOS N-channel, Si-gate	413252	89536	413252	1	1	
U33	IC, dgtl, MOS N-channel, Si-gate	418020	89536	418020	1	1	
1	Case, half, module	402990	89536	402990	2		
	Case, cover module (Not Shown)	402974	89536	402974	1		
	Decal (Not Shown)	413542	89536	413542	1		
A6A1 Ⓧ	**CONTROLLER PCB ASSEMBLY**						
C1	Cap, mica, 15 pF ±5%, 500V	148569	72136	DM15C150J	1		
C2	Cap, mica, 47 pF ±5%, 500V	148536	72136	DM15E470J	1		
C3, C4, C5, C7 C11 thru C17, C20, C21, C23, C32	Cap, cer, 10,000 pF ±20%, 100V	407361	72982	8131-A100-W5 R-103M	15		
C6, C28	Cap, cer 0.022 μF −20/+100%, 40V	358325	72982	8121-A050-651-223Z	2		
C8, C9	Cap, mica, 4 pF ±0.5 pF, 500V	190397	72136	DM15C040E	2		
C10	Cap, cer, 1 μF ±20%, 50V	436782	51642	300-050-601-105M	1		
C18	Cap, Ta, 15 μF ±20%, 6V	161935	56289	196D156X-0006-KA1	1		
C19	Cap, cer, 0.22 μF ±20%, 50V	309849	71590	CW30C224K	1		
C22	Cap, elect, Ta, 1 μF ±5%, 15V	461152	56289	150D106X-5015A2	1	1	
C24, C27	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	2		
C25	Cap, Ta, 39 μF ±20%, 6V	163915	56289	196D396X-0006	1		

A6A1 CONTROLLER PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C26	Cap, cer, 2200 pF ±10%, 500V	268425	72982	851-000-Z5R-222K	1		
C29, C30, C31	Cap, Ta, 2.2 μF ±20%, 20V	161927	56289	196D225X-0020HA1	3		
C33	Cap, Ta, 150 μF ±20%, 6V	460204	56289	183DR157X 0006F	1		
CR1	Diode, hi-speed, switching	203323	07910	1N4448	1		
R1	Res, var, cermet, 10k ±10%, 1/2W	285171	89536	285171	1	1	
R2, R17, R25, R28	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	4		
R3, R8, R9, R10, R11, R16	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	6		

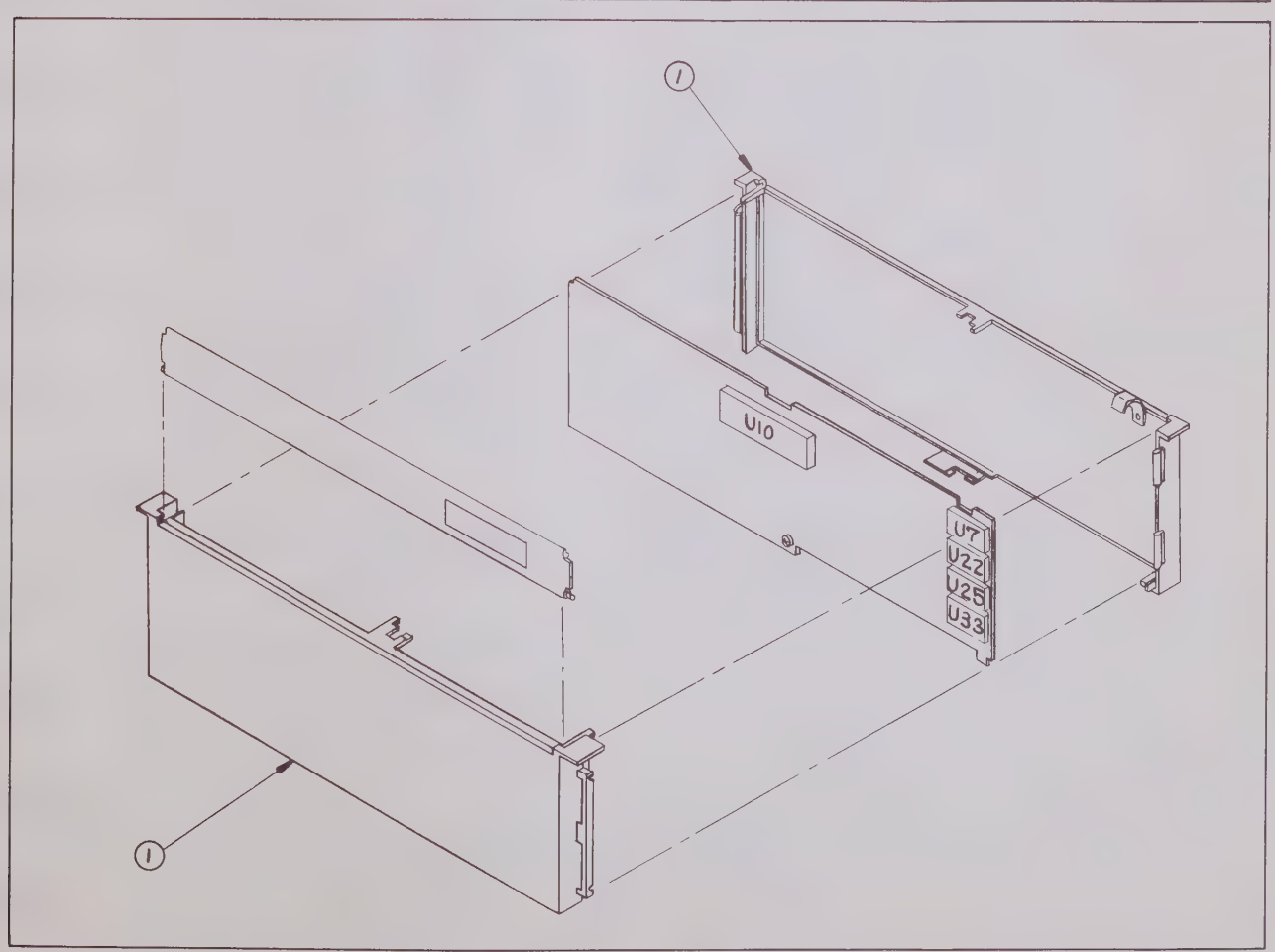


Figure 5-5. A6, Controller Module Assembly (Sheet 1 of 2)

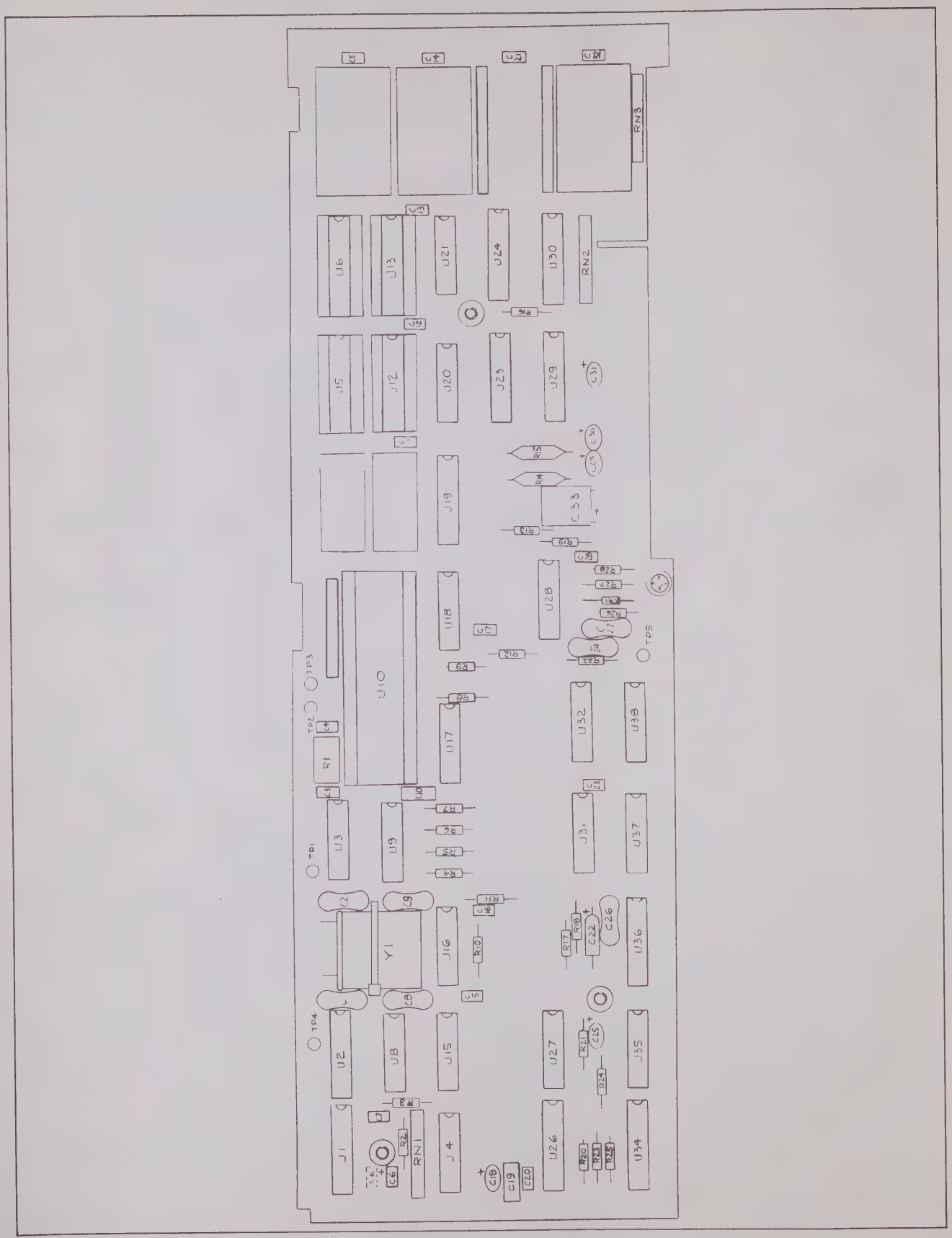


Figure 5-5. A6A1, Controller PCB Assembly (Sheet 2 of 2)

A6A1 CONTROLLER PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R4, R7, R19, R27	Rex, comp, 2k ±5%, 1/4W	202879	01121	CB2025	4		
R5, R21	Res, comp, 6.8k ±5%, 1/4W	148098	01121	CB6825	2		
R6	Res, comp, 10M ±5%, 1/4W	194944	01121	CB1065	1		
R12, R13, R20	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	3		
R14	Res, mf, 715 ±1%, 1/8W	313080	91637	MFF1-87150F	1		
R15	Res, mf, 523 ±0.5%, 1/8W	294835	91637	MFF1-85230D	1		
R18	Res, mtl film, 23.2k ±1%, 1/8W	291351	91637	CMF552322F	1		
R22	Res, comp, 3k ±5%, 1/4W	193508	01121	CB3025	1		
R23	Res, comp, 680k ±5%, 1/4W	188433	01121	CB6845	1		
R24	Res, comp, 1.5k ±5%, 1/4W	148031	01121	CB1525	1		
R26	Res, comp, 30k ±5%, 1/4W	193417	01121	CB3035	1		
RN1, RN2	Res Network	412916	89536	412916	2	1	
RN3	Res Network	412924	89536	412924	1	1	
U1	IC, Dgtl, TTL, LPS, dual J-K flip-flop	412999	01295	SN74LS109N	1	1	
U2	⊗ IC, Dgtl, C-MOS, hex, buffer/inverters	381830	02735	CD4050AE	1	1	
U3	⊗ IC, Dgtl, C-MOS, fast, quad 2-input, NAND gate	413211	07263	34011PC64011 PC	1	1	
U5, U6, U12, U13	⊗ IC, Dgtl, MOS, 1024 bit, static RAM	404558	34649	P2111-1	4	1	
U8	IC, Dgtl, TTL, AND-OR, invert gates	412981	01295	SN74LS51	1	1	
U9	⊗ IC, Dgtl, C-MOS, hex inverter	404699	12040	MM74C04N	1	1	
U14, U35	⊗ IC, C-MOS, dual, type "D" flip-flop	340117	04713	MC14013CP	2	1	
U15	IC, Dgtl, TTL, quad 2-input, pos, AND gates	393066	01295	SN74LS08	1	1	
U16, U21	IC, Dgtl, TTL, hex inverter, pos NAND gates	393058	01295	SN74LS04	2	1	
U17	⊗ IC, Dgtl, C-MOS, quad 2-input, NAND gates	375147	02735	CD4023AE	1	1	
U18	IC, Dgtl, TTL, hex/quad, D type flip-flop, w/c	393207	01295	SN74LS174N	1	1	

A6A1 CONTROLLER PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U19, U29	Ⓧ IC, Dgtl, C-MOS, strobed, hex inverter/ buffer	408211	04713	MC14502CP	2	1	
U20	IC, Dgtl, TTL, 2-independent, 2-4line, dcdr/multiplxr	393165	01295	SN74LS139N	1	1	
U23, U24, U30	Ⓧ IC, Dgtl, C-MOS, Tri-State NON-inverting buffers	407759	12040	MM80C97N	3	1	
U26	Ⓧ IC, lin, COS/MOS, phase locked loop	403584	02735	CD4046AE	1	1	
U27	Ⓧ IC, Dgtl, C-MOS, quad 2-input, OR gate	408393	02735	CD4071BE	1	1	
U28	Ⓧ IC, Dgtl, C-MOS, 8-bit, priority encoder	412973	02735	CD4523BE	1	1	
U31	IC, Dgtl, TTL, triple-input, POS NAND gates and inverters	393074	01295	SN74LS10N	1	1	
U32	Ⓧ IC, Dgtl, C-MOS, hex inverter	404681	02735	CD4069BE	1	1	
U34	Ⓧ IC, Dgtl, C-MOS, dual, up-counter	355164	04713	MC14520CL/CP	1	1	
U36	Ⓧ IC, Dgtl, C-MOS, retriggerable/resettable monostable multivibrator	454017	04713	MC14538BCP	1	1	
U37	Ⓧ IC, Dgtl, C-MOS, quad 2-input NOR gates	429944	02735	CD4001BE	1	1	
U38	Ⓧ IC, Dgtl, C-MOS, quad 2-input NAND	404632	02735	CD4039BE	1	1	
Y1	Crystal, quartz	412932	89536	412932	1		
1	Clamp, nylon strap	172080	06383	SST1M	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Shield, cover	440008	89536	440008	1		
	Socket, IC, 18 pins	418228	91506	318-AG39D	6		
	Socket, IC, 24 pins	418970	91506	324-SG39D	3		
	Socket, IC, 40 pins	418988	91506	340-AG39D	1		
	Socket, IC, 9 pins	436774	30035	SS-109-1-09	1		
	Socket, IC, 12 pins	417733	30035	SS-109-1-12	2		
1	Not Shown						

A7 DISPLAY PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7	DISPLAY PCB ASSEMBLY (8500A-4021) Figure: 5-6	384032	89536	384032	REF		
C1	Cap, cer, 0.22 uF ±20%, 50V	309849	71590	CW30C224K	1		
C2	Cap, Ta, 5.6 uF ±20%, 25V	368969	56289	196D565X0025 KA1	1		
C3	Cap, cer, 1200 pF ±20%, 100V	358283	80031	2222-630-01-122	1		
CR1 thru CR4	Diode Hi-speed Switching	203323	07910	1N4448	4	1	
CR7	Diode, LED	413831	29083	MV5153	1	1	
F1	Fuse, fast-blo	109330	71400	AGC11-2	1	5	
J1, J2	Binding Post, red	275552	32767	820-65	2		
J3, J4	Binding Post, blk	275560	32767	820-45	2		
J5	Binding Post, blue	275578	32767	820-55	1		
L1	Coil Assembly	438325	89536	438325	1		
Q1	Xstr, Si, NPN	330803	04713	MPS6560	1	1	
Q2 thru Q8	Xstr, Si, PNP	340026	04713	MPS6563	7	2	
Q10	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, comp, 62 ±5%, 1/4W	261842	01221	CB6205	1		
R2, R6	Res, comp, 200 ±5%, 1/4W	193482	01121	CB2015	2		
R3	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
R4	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R5	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	1		
R7	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R8	Res, comp, 10M ±5%, 1/4W	194944	01121	CB1065	1		
S1 thru S8, S10 thru S18	Switch, actuator	412106	89536	412106	17		

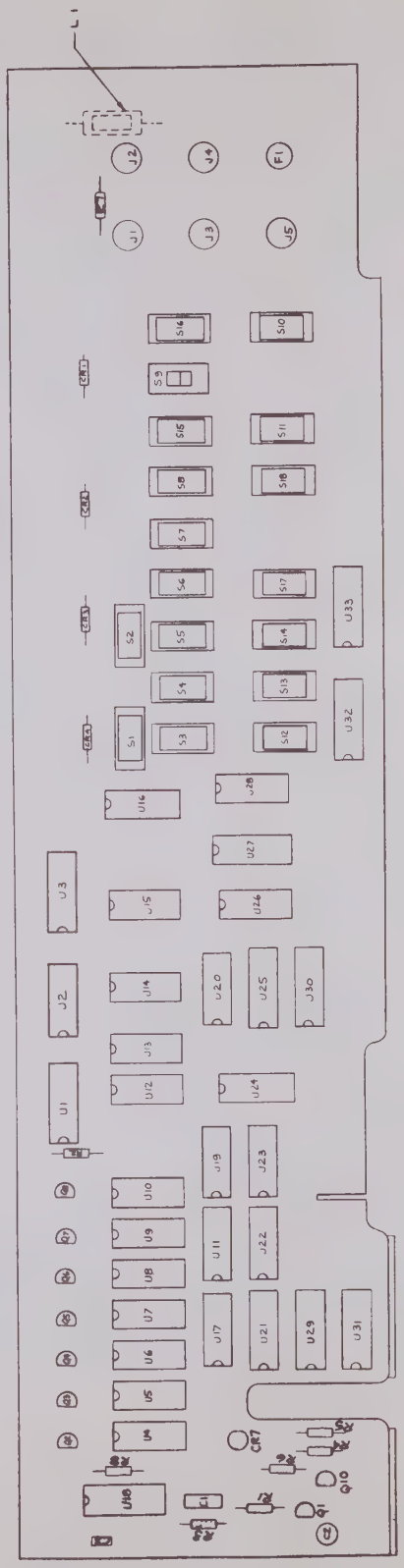


Figure 5-6. A7, Display PCB Assembly

A7 DISPLAY PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
S1 thru S8, S10 thru S18	Switch, top cover	401299	89536	401299	17		
S1 thru S8, S10 thru S18	Spring, switch, pushbutton	414516	00779	62353-3	17		
S1 thru S8, S10 thru S18	Contact, switch, pushbutton	416875	00779	62380-4	17		
S1 thru S5, S15 thru S17	SW, pushbutton, lt putty grey	401307	89536	401307	8		
S6, S7, S8, S12, S13, S14	SW, pushbutton, dk putty grey	406728	89536	406728	6		
S9	Switch Slide, spdt	417287	95146	MSS-104D-1	1		
S10, S11	Pushbutton, med, yellow, sw	419937	89536	419937	2		
S18	Pushbutton, blue, sw	406736	89536	406736	1		
U1, U21, U25	IC, lin, NPN, xstr array	407866	02735	CA3081	3	1	
U2	⊗ IC, C-MOS, hex inverter	404681	02735	CD4069BE	1	1	
U3, U27, U31	⊗ IC, C-MOS, hex "D" flip-flop	404509	12040	MM74C174N	3	1	
U4, U12	Display, LED	453282	29083	MAN4630A	2	1	
U5 thru U10, U13	Display Set	440016	89536	440016	1	1	
U11	⊗ IC, Dig, C-MOS, quad, 2-input NAND gate	355198	02735	CD4011AE	1	1	
U14, U15, U24, U26	Display, LED	453274	29083	MAN4610A	4	1	
U16, U22 U23	⊗ IC, C-MOS, dual, flip-flop	340117	04713	MC14013CL	3	1	
U17, U20	Res Network 4.7k	344069	89536	344069	2	1	
U18	⊗ IC, Dig, C-MOS, retriggerable/resettable monostable/multivibrator	393512	04713	MC14528CP	1	1	

A7 DISPLAY PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U19	⊗ IC, C-MOS, dual 4-input, NAND gate	355206	04713	MC14012CP	1	1	
U28	⊗ IC, C-MOS, triple 3-input NAND gate	375147	04713	MC14023CP	1	1	
U29, U30	Res, dual, in-line package	358119	89536	358119	2	1	
U32	⊗ IC, C-MOS, tri-state, hex non-inverting buffer	407759	12040	MM80C97N	1	1	
U33	Res Network	386961	89536	386961	1	1	
1	Cap, fuse	455857	89536	455857	1		
	Fuseholder	435628	89536	435628	1		
	Insulator Binding Post	449363	89536	449363	1		
	Mask LED	418996	89536	418996	4		
	Shield Front Panel	433524	89536	433524	1		
	Socket, IC	453514	71785	133-59-90-0901/ 14E	13		
	Spacer	446641	11897	167-PB-0588	1		
	Spark Gap	442731	25088	B1C145	1		
1	Not Shown						

A8 D.C. SIGNAL CONDITIONER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8 Ⓧ	**D.C. SIGNAL CONDITIONER ASSEMBLY (MIS-4100) (Tested)** **Figure: 5-7**	383901	89536	383901	REF		
C1, C2	Cap, Ta, 5.6 uF ±20%, 25V	368969	56289	196D565X0025 KA1	2		
C3, C4	Cap, cer, 0.22 uF ±20%, 50V	309849	71590	CW30C224K	2		
C5	Cap, Ta, 39 uF ±20%, 6V	163915	56289	196D396X0006 KA1	1		
C10, C11	Cap, elect, 6.8 uF –10/+50%, 63V	218966	73445	ET6P8X063A3	2	1	
C12, C14	Cap, mica, 100 pF ±5%, 500V	148494	72136	DM15F101J	2		
C13	Cap, cer, 0.01 uF ±	149153	56289	33C41B6	1		
C15, C16	Cap, mica, 47 pF ±5%, 500V	148536	72136	DM15E470J	2		
C18, C19	Cap, cer, 33 pF ±2%, 100V	354852	80031	2222-638-10339	2		
CR1, CR2	Diode, Hi-speed switching	203323	07910	1N4448	2	1	
CR3, CR4	Diode, zener	181073	07910	1N969B	2	1	
K1, K2	Relay, armature, lo-profile	441261	77342	R40-E0186-1	2		
Q1, Q3	Xstr, NPN, Si	330803	07263	MPS6560	2	1	
Q2, Q4, Q6, Q31, Q33, Q35	Xstr, PNP, Si	195974	04713	2N3906	6	2	
Q5	Xstr, PNP, Si	226290	04713	MPS3640	1	1	
Q7, Q10 thru Q13, Q22, Q23, Q32, Q34, Q36, Q38	Xstr, NPN, Si	218396	04713	2N3904	11	3	
Q8, Q14, Q15, Q16	Xstr, FET, N-channel	393314	89536	393314	4	1	
Q18	Xstr, NPN, Si	284075	32293	IT1099	1	1	
Q19	Xstr, NPN, Si	295717	24355	AD811-00/17	1	1	
Q37	Xstr, PNP, Si	218388	07263	2N3645	1	1	

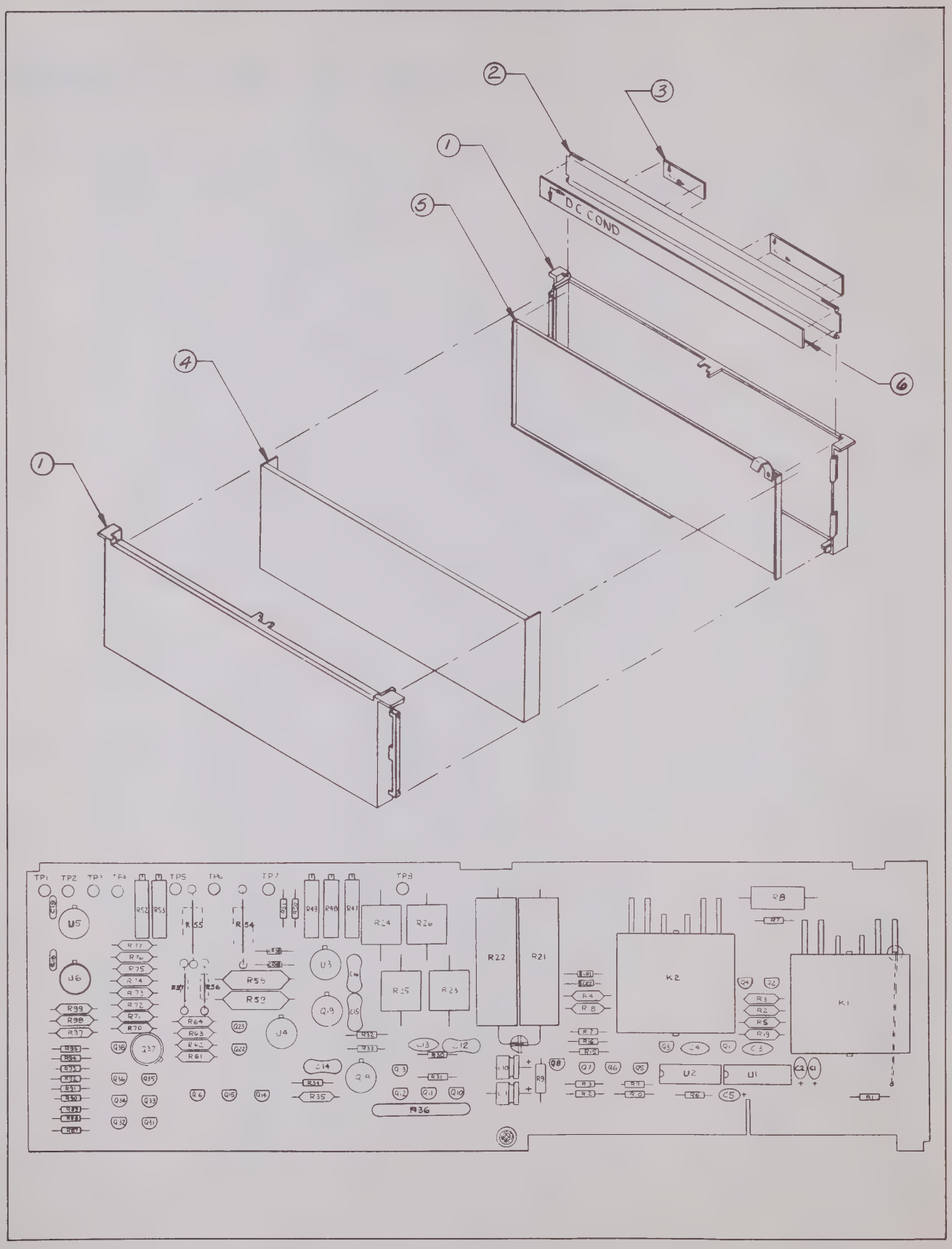


Figure 5-7. A8, D.C. Signal Cond. Case and PCB Assembly

A8 D.C. SIGNAL CONDITIONER PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R1	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R2, R3	Res, mf, 28.0k ±1%, 1/8W	291385	91637	MFF1-82802F	2		
R4, R18	Res, mf, 21k ±1%, 1/8W	441212	91637	MFF1-82102F	2		
R5, R19	Res, mf, 17.8k ±1%, 1/8W	349183	91637	MFF1-81782F	2		
R6	Res, car, dep, 470 ±5%, 1/4W	343434	80031	CR251-45P471T	1		
R7, R31, R32, R33, R34	Res, car, dep, 10k ±5%, 1/4W	348839	80031	CR251-45P103T	5		
R8	Res, comp, 150k ±5%, 2W	110122	01121	HB1545	1		
R9	Res, comp, 150k ±10%, 1/2W	108167	01121	EB15415	1		
R10	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R11	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R12, R13	Res, comp, 15 ±5%, 1/4W	147876	01121	CB1505	2		
R15, R93, R94, R95	Res, car, dep, 1M ±5%, 1/4W	348987	80031	CR251-45P105T	4		
R16, R17, R87, R88, R89, R90, R91, R92	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	8		
R21, R22, R23	Res, divider set	434605	89536	434605	1	1	
R24, R25, R26	Res, DC range set	409938	89536	409938	1	1	
R30	Res, car dep, 15k ±5%, 1/4W	348854	80031	CR251-45P153T	1		
R35, R62	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	2		
R36	Res, cermet, 100M ±10%, 1W	441758	89536	441758	1		
R47	Res, var, 200 ±20%, 1/2W	284711	71450	190PC201B	1	1	
R48, R49	Res, var, cermet, 50 ±20%, 1/2W	267815	71450	190PC500B	2	1	
R50	Res, car, dep, 2.2 ±5%, 1/4W	354944	80031	CR251-45P2E2T	1		
R51	Res, car, dep, 20 ±5%, 1/4W	442202	80031	CR251-45P20ET	1		
R52	Res, var, cermet, 100k ±20%, 1/2W	268581	71450	190PC104B	1	1	

A8 D.C. SIGNAL CONDITIONER PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R53	Res, var, cermet, 10k ±20%, 1/2W	267880	71450	190PC103B	1	1	
R54, R55, R56, R57	Res, selected, during test				4	1	
R58, R59	Res, set, matched	290230	89536	290230	1	1	
R61	Res, mf, 86.6k ±1%, 1/8W	291468	91637	MFF1-88662F	1		
R63	Res, mf, 1.87k ±1%, 1/8W	267229	91637	MFF1-81871F	1		
R64	Res, mf, 1k ±1%, 1/8W	168229	91637	MFF1-81002F	1		
R70	Res, mf, 52.3k ±1%, 1/8W	237248	91637	MFF1-85232	1		
R71	Res, mf, 3.01k ±1%, 1/8W	312645	91637	MFF1-83011F	1		
R72, R97	Res, mf, 3.65k ±1%, 1/8W	293779	91637	MFF1-83651F	2		
R73, R74	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	2		
R75, R99	Res, mf, 80.6k ±1%, 1/8W	281121	91637	MFF1-88062F	2		
R76	Res, mf, 4.02 ±1%, 1/8W	235235	91637	MFF1-84021F	1		
R77	Res, mf, 200k ±1%, 1/8W	261701	91637	MFF1-82003F	1		
R98	Res, mf, 2.15k ±1%, 1/8W	293712	91637	MFF1-82151F	1		
U1	⊗ IC, Dgtl, COS/MOS, quad clocked "D" latch	355149	02735	CD4042AE	1	1	
U2	⊗ IC, Dgtl, C-MOS, triple, 3-input, NAND gates	375147	02735	CD4023AE	1	1	
U3, U4	IC, Op Amp, J-FET, input	310037	12040	LH0042CA	2	1	
U5, U6	IC, Op, Amp	271502	12040	LM301A	2	1	
1	Case Half	402990	89536	402990	2		
2	Cover	402974	89536	402974	1		
3	Decal	413377	89536	413377	1		
4	Guard, front	383356	89536	383356	1		
5	Guard, rear	383364	89536	383364	1		
6	Shield, cover	411918	89536	411918	1		
	Socket, spring type (Not Shown)	343285	00779	2-331272-6	8		
	Spacer, transipad (use with Q37)(Not Shown)	152207	07047	10123-DAP	1		
	Spacer (Not Shown)	334797	32559	T0-35-15	1		
	Terminal, feed-thru (Not Shown)	281865	12615	SL-841-777	1		

A9 ACTIVE FILTER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9 Ⓢ	**ACTIVE FILTER ASSEMBLY** **Figure: 5-8 (M.I.S.4130) Tested**	383745	89536	383745	REF		
C1, C2, C3	Cap, polyprop, 0.047 uF ±10%, 50V	413328	89536	413328	3		
C4, C8, C9, C10	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	4		
C5, C6, C7	Cap, polyprop, 0.47 uF ±10%, 50V	363085	89536	363085	3		
C11, C14	Cap, elect, 6.8 uF −10/+50%, 6.3V	218966	73445	ET6P8X063A3	2	1	
C12, C13	Cap, elect, 10 uF −10/+50%, 25V	170266	73445	ET100X25A2	2	1	
C15	Cap. polyprop, 0.0022 ±10%, 200	442632	89536	442632	1	1	
CR1	Diode, zener	260695	07910	1N754A	1	1	
CR2	Diode, zener	386557	07910	1N960A	1	1	
CR3	Diode, zener	203323	07910	1N4448	1	1	
Q1, Q3, Q5, Q7, Q9, Q11	Xstr, Si, PNP	195974	04713	2N3906	6	2	
Q2, Q4, Q6, Q8, Q10, Q12, Q28, Q29, Q30	Xstr, Si, NPN	218396	04713	2N3904	9	2	
Q13	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
Q14 thru Q25, Q31, Q32	Xstr, FET, N-channel	393314	89536	393314	14	3	
Q26	Xstr, Si, PNP	218388	07263	2N3645	1	1	
Q27	Xstr, Si, NPN	284075	32293	IT1099	1	1	
R1	Res, carbon, dep, 6.2k ±5%, 1/4W	442368	80031	CR251-45P622T	1		
R2	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R3	Res, mf, 51.1k ±5%, 1/8W	289553	91637	MFF1-85112F	1		
R4, R5	Res, comp, 8.2k ±5%, 1/4W	160796	01121	CB8225	2		
R8 thru R11	Res, mf 45.3k ±1%, 1/8W	234971	91637	MFF1-84532F	4		

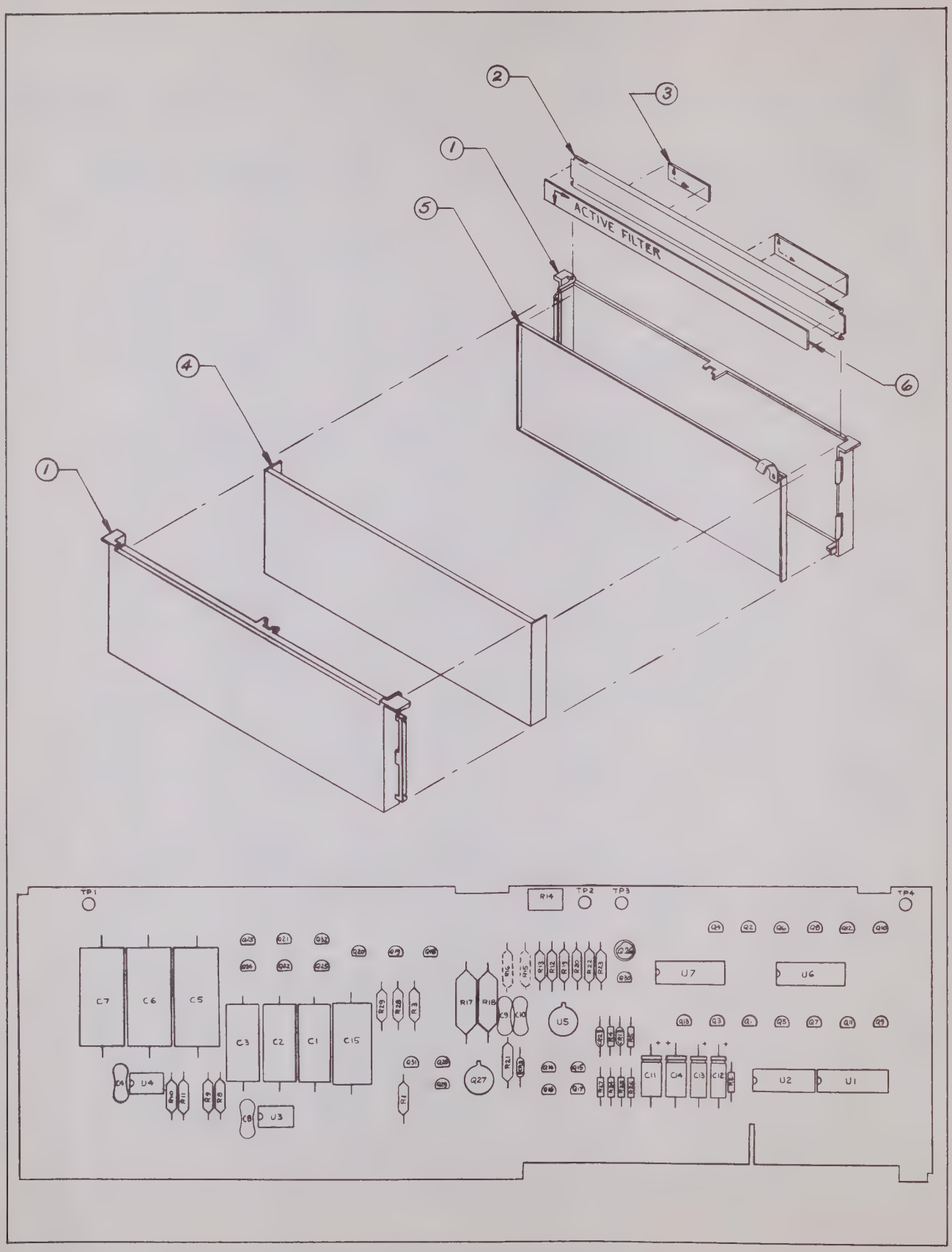


Figure 5-8. A9, Active Filter Case and PCB Assembly

A9 ACTIVE FILTER ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12, R19, R22	Res, mf, 12.1k ±1%, 1/8W	234997	91637	MFF1-81212F	3		
R13	Res, mf, 4.87k ±1%, 1/8W	294850	91637	MFF1-84871F	1		
R14	Res, var, cermet, 20k ±10%, 1/2W	291609	89536	291609	1	1	
R15, R16	Res, selected, during test						
R17, R18	Res, mf, 1M ±1%, 1/2W	327510	91637	MFF1-21004F	2		
R20, R23	Res, mf, 249k ±1%, 1/8W	268805	91637	MFF1-82493F	2		
R21	Res, mf, 57.6k ±1%, 1/8W	289116	91637	MFF1-85762F	1		
R24, R27	Res, comp, 15 ±5%, 1/4W	147876	01121	CB1505	2		
R25, R26	Res, comp, 100 ±5%, 1/4W	147926	01121	CB1015	2		
R28, R29	Res, mf, 26.7k ±1%, 1/8W	245779	91637	MFF1-82672F	2		
U1	⊗ IC, Dgtl, C-MOS, hex, "D" flip-flop	404509	12040	MM74C174N	1	1	
U2	⊗ IC, Dgtl, C-MOS, triple , 3-input NAND gates	375147	02735	CD4023AE	1	1	
U3, U4	IC, lin, op-amp	363515	12040	LM301AN	2	1	
U5	IC, lin, op-amp	392902	12040	LM1346H	1	1	
U6	Res Network, 100k ±10%, 1/4W	404749	89536	404749	1	1	
U7	Res Network, 100k ±10%, 10V	380618	89536	380618	1	1	
1	Case Half	402990	89536	402990	2		
2	Cover	402974	89536	402974	1		
3	Decal	413443	89536	413443	1		
4	Guard, front	383356	89536	383356	1		
5	Guard, rear	383364	89536	383364	1		
6	Shield, cover	411959	89536	411959	1		
	Socket, spring type (Use with R15, R16) (Not Shown)	343285	00779	2-331272-6	4		
	Spacer (Use with Q26) (Not Shown)	152207	07047	10123DAP	1		

A10 FAST R² A/D CONVERTER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10 Ⓧ	**FAST R² A/D CONVERTER ASSEMBLY**						
A10A1	A/D Analog Assembly (MIS-4140)	383752	89536	383752	1		
A10A2	Ⓧ A/D Digital Assembly (MIS-4141)	383760	89536	383760	1		
A10A1	**A/D ANALOG ASSEMBLY** **Figures: 5-9 and 5-10**						
C1, C2	Cap, Ta, 10 μF ±20%, 35V	417683	56289	196D106X 0035KA1	2		
C3	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	1		
C4	Cap, mica, 30 pF ±5%, 500V	340570	72136	DM15E300J	1		
C5	Cap, film, 0.22 μF±10%, 80V	159392	56289	192P2249R8	1		
C6	Cap, Ta, 4.7 μF ±20%, 25V	161943	56289	196D475X 0025KA1	1		
C7, C8	Cap, mica, 150 pF ±5%, 500V	148478	72136	DM15F151J	2		
C9, C10	Cap, polyst, 0.047 μF ±10%, 100V	260562	84411	863UW47391	2		
C11, C12, C14	Cap, mica, 47 pF ±5%, 500V	148536	72136	DM15E470J	3		
C13	Cap, elect, 470 μF −10/+50%, 6.3V	187773	73445	ET471X6P3A6	1	1	
C15	Cap, cer, 0.0047 μF ±10%, 500V	106724	71590	CF-472	1		
C16, C17	Cap, cer, 0.22 μF ±20%, 50V	309849	71590	CW30C224K	2		
C20	Cap, Ta, 0.22 μF ±20%, 35V	161331	56289	196D224X 0035HA1	1		
C21	Cap, mica, 1800 pF ±5%, 500V	148353	72136	DM19F182J	1		
CR1, CR9	Diode, Hi-speed, switching	203323	07910	1N4448	2	1	
CR3, CR4, CR7, CR8	Diode, Si lo-cap, lo-leak	348177	07263	FD7223	4	1	
CR5, CR6	Diode, Si, controller fwd vol	234468	07910	TD9039	2	1	
J1, J2	Socket I	276535	91506	316-AG39D	2		
Q1, Q2 Q3, Q11 thru Q16, Q25, Q26	Xstr, FET, set (selected	256487	89536	256487	1	1	
Q4 thru Q8	Xstr, FET, N-channel	343830	89536	343830	5	1	
C18	Cap, Ta, 68 μF ±20%, 25V	446450	56289	196D686X 0025TE4	1		

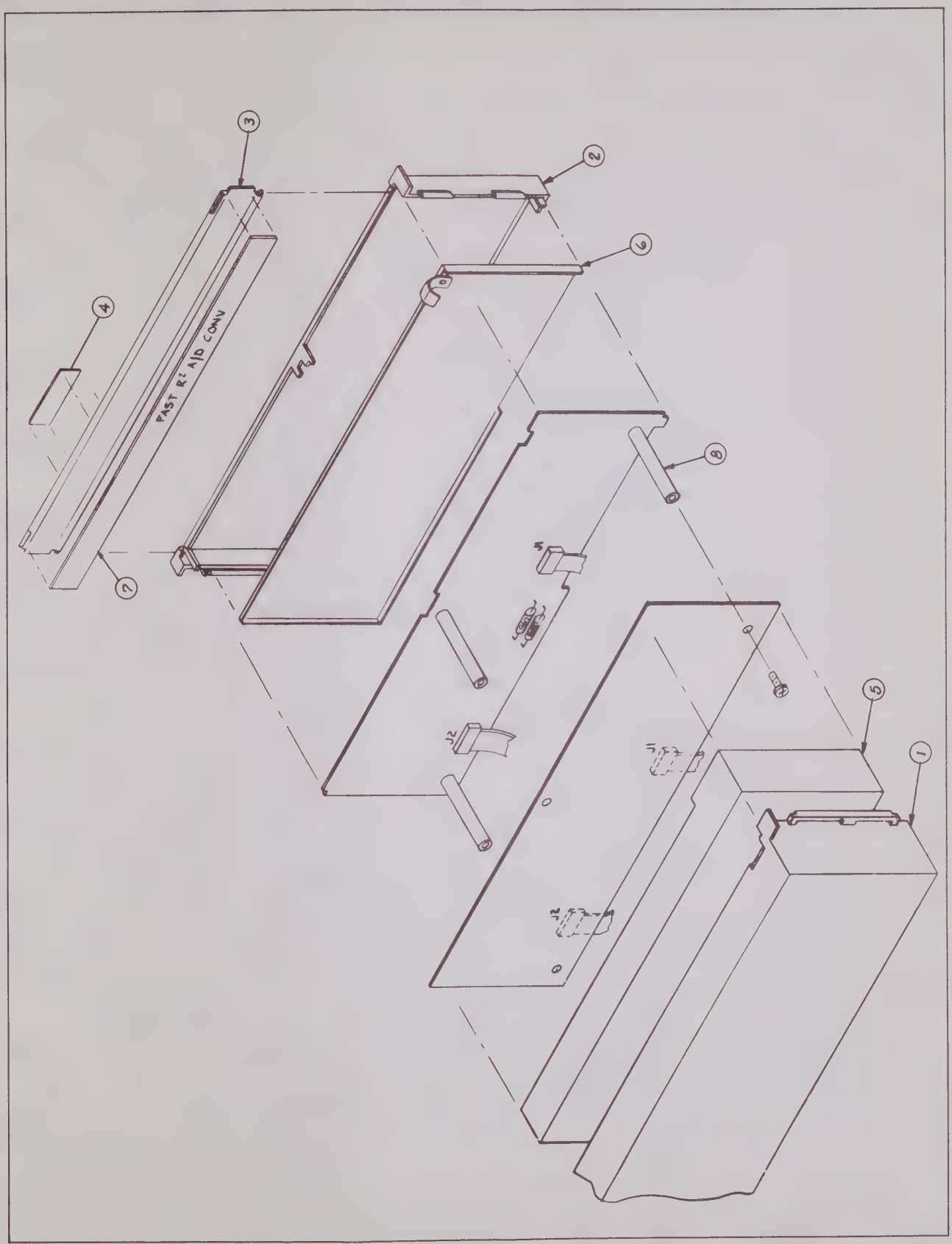


Figure 5-9. A10 Fast R^2 A/D Converter Case Assembly

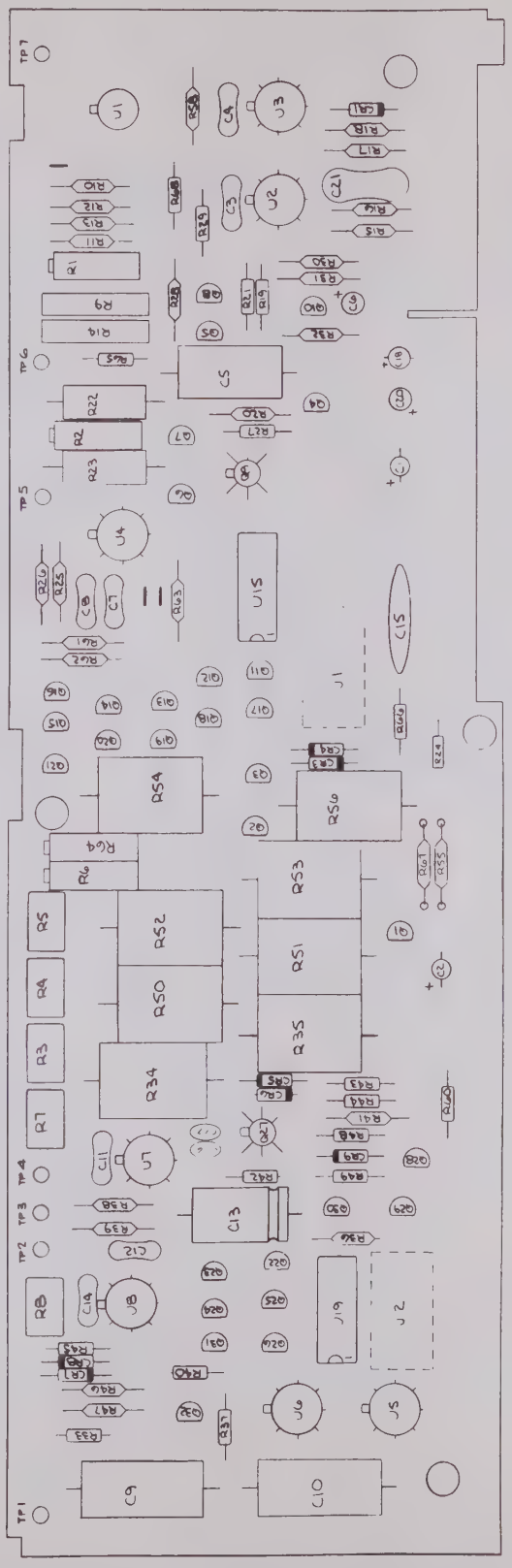


Figure 5-10. A10A1, Fast R² A/D Converter (Analog) PCB Assembly

A10A1 FAST R² A/D CONVERTER ANALOG ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q9, Q27	Xstr, FET, dual, N-channel	376087	89536	376087	2	1	
Q10	Xstr, Si, NPN	218396	04713	2N3904	1	1	
Q17 thru Q24, Q29 thru Q32	Xstr, FET, N-channel	261578	89536	261578	12	3	
Q28	Xstr, Si, PNP	195974	04713	2N3906	1	1	
R1	Res, var, cermet, 500 ±20%, 1/2W	267849	75378	190PC501B	1	1	
R2, R64	Res, var, cermet, 10 ±20%, 1/2W	344135	75378	190PC100B	2	1	
R3	Res, var, cermet, 500 ±10%, 1/2W	291120	89536	291120	1	1	
R4	Res, var, cermet, 200 ±10%, 1/2W	285148	89536	285148	1	1	
R5, R7	Res, var, cermet, 50 ±10%, 1/2W	285122	89536	285122	2	1	
R6	Res, var, cermet, 20 ±20%, 1/2W	261180	75378	190PC200B	1	1	
R8	Res, var, cermet, 50k ±10%, 1/2W	288290	89536	288290	1	1	
R9, R14, R15, R16, U1	Ref Amp Set	415034	89536	415034	1	1	
R10	Res, mf, 3.4k ±1%, 1/8W	260323	91637	MFF1-83401F	1		
R11, R13	Res, mf, 12.1 ±1%, 1/8W	296608	91637	MFF1-812R1F	2		
R12	Res, mf, 24.3 ±1%, 1/8W	281816	91637	MFF1-824R3F	1		
R17, R18	Res, mf, 10k ±1%, 1/8W (T9)	328120	91637	MFF1-81002F	2		
R19, R21, R49	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	3		
R20, R28, R30	Res, mf, 10k ±1%, 1/8W (T0)	168260	91637	MFF1-81002F	3		
R22, R23	Res, Ref Inverter Set	409896	89536	409896	1		
R24	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	1		
R25, R26	Res, mf, 49.9k ±1%, 1/8W	268821	91637	MFF1-84992F	2		
R27	Res, comp, 62 ±5%, 1/4W	261842	01121	CB6205	1		
R29, R60	Res, comp, 33k ±5%, 1/4W	148155	01121	CB3335	2		
R31	Res, mf, 11.3k ±1%, 1/8W	293639	91637	MFF1-81132F	1		
R32	Res, mf, 24.9k ±1%, 1/8W	291369	91637	MFF1-82492F	1		

A10A1 FAST R^2 A/D CONVERTER ANALOG ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R33, R37	Res, comp, 47 ±5%, 1/4W	147892	01121	CB4705	2		
R34, R35, R50 thru R54, R56	Res, Set	409946	89536	409946	1	1	
R36	Res, mf, 26.7k ±1%, 1/8W	245779	91637	MFF1-82672F	1		
R38, R39, R41	Res, mf, 75k ±1%, 1/8W	291443	91637	MFF1-87502F	3		
R40, R48	Res, comp, 15k ±5%, 1/4W	148114	01121	CB1535	2		
R42	Res, comp, 3k ±5%, 1/4W	193508	01121	CB3025	1		
R43	Res, comp, 510 ±5%, 1/4W	218032	01121	CB5115	1		
R44	Res, comp, 1.5k ±5%, 1/4W	148031	01121	CB1525	1		
R45	Res, comp, 470k ±5%, 1/4W	188441	01121	CB4745	1		
R46	Res, mf, 665 ±1%, 1/8W	320028	91637	MFF1-86650F	1		
R47	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	1		
R55	Res, mf, 56.2 ±1%, 1/8W	305938	91637	MFF1-856R2F	1		
R58	Res, mf, 2573 ±0.1%, 1/8W	321463	91637	MFF1-82573F	1		
R61	Res, mf, 57.6k ±1%, 1/8W	289116	91637	MFF1-85762F	1		
R62	Res, mf, 66.5k ±1%, 1/8W	289082	91637	MFF1-86652F	1		
R63	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	1		
R65	Res, comp, 820 ±5%, 1/4W	148015	01121	CB8215	1		
R66	Res, comp, 5.1k ±5%, 1/4W	193342	01121	CB5125	1		
R67	Res, mf, 18.7 ±1%, 1/8W	441776	91637	MFF1-812R7F	1		
R68	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	1		
U1, R9, R14, R15, R16	Ref Amp Set (See R9)	415034	89536	415034	REF		
U2, U3	IC, Op-Amp	271502	12040	LM301A	2	1	
U4, U7	IC, Op-Amp, J-FET, input	310037	12040	LH0042CH	2	1	
U5, U6	IC, lin, vol, follower	288365	12040	LM310H	2	1	
U8	IC, Op-Amp	225961	24355	AD3092	1	1	

A10A1 FAST R² A/D CONVERTER ANALOG ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U15	Res Network, 33k	413146	89536	413146	1	1	
U19	Res Network, 100k	380618	89536	380618	1	1	
1	Case Half	402990	89536	402990	1		
2	Case Half	402982	89536	402982	1		
3	Cover	402974	89536	402974	1		
4	Decal	413450	89536	413450	1		
5	Guard, front	383315	89536	383315	1		
6	Guard, rear	383364	89536	383364	1		
7	Shield, cover	411967	89536	411967	1		
8	Spacer	152207	07047	10123DAP	1		

A10A2 FAST R² A/D CONVERTER DIGITAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A2 Ⓧ	**FAST R² A/D CONVERTER DIGITAL ASSEMBLY (MIS-1741) Figure 5-11**	383760	89536	383760	REF		
C1	Cap, Ta, 220 uF ±20%, 6V	408682	56289	196D227X0006TE4	2		
C2, C3	Cap, mica, 82 pF ±5%, 500V	148502	72136	DM15F820J	2		
J1, J2	Cable Assy, 16 pin conn	380576	08261	5122-003.5	2		
Q1	Xstr, Si, PNP	226290	04713	MPS3640	1		
R1	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R2, R3	Res, comp, 20k ±5%, 1/4W	221614	01121	CB2035	2		
R4	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R5, R6	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	2		
R7	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
U1, U2, U6, U11, U12, U22, U32, U34, U35	Ⓧ IC, C-MOS, dual type "D" flip-flop	340117	02735	CD4013AE	9	2	
U3, U7, U21	Ⓧ IC, Dgtl, C-MOS, hex inverter	404681	02735	CD4069BE	3	1	
U4, U13, U37	Res Network	380618	89536	380618	3	1	
U5	Ⓧ IC, Dgtl, COS-MOS, dual, complementray pair	408013	02735	CD4007AE	1	1	
U8, U36	Ⓧ IC, Dgtl, C-MOS, quad, 2-input NAND gates	355198	02735	CD4011AE	2	1	
U14, U15, U17, U23, U38	IC, Linear, 5-xstr array	380188	02735	CA3183E	5	1	
U16, U26	Ⓧ IC, Dgtl, C-MOS, quad, 2-input OR gate	408393	02735	CD4071BE	2	1	
U25	Ⓧ IC, Dgtl, C-MOS, quad, 2-input, AND gate	408401	02735	CD4081BE	1	1	
U31	Ⓧ IC, Dgtl, C-MOS, divide by −8, counter/ divider	403360	02735	CD4022AE	1	1	
U33	Ⓧ IC, Dgtl, C-MOS, quad, 2-input NAND gates	375147	02735	CD4023AE	1	1	

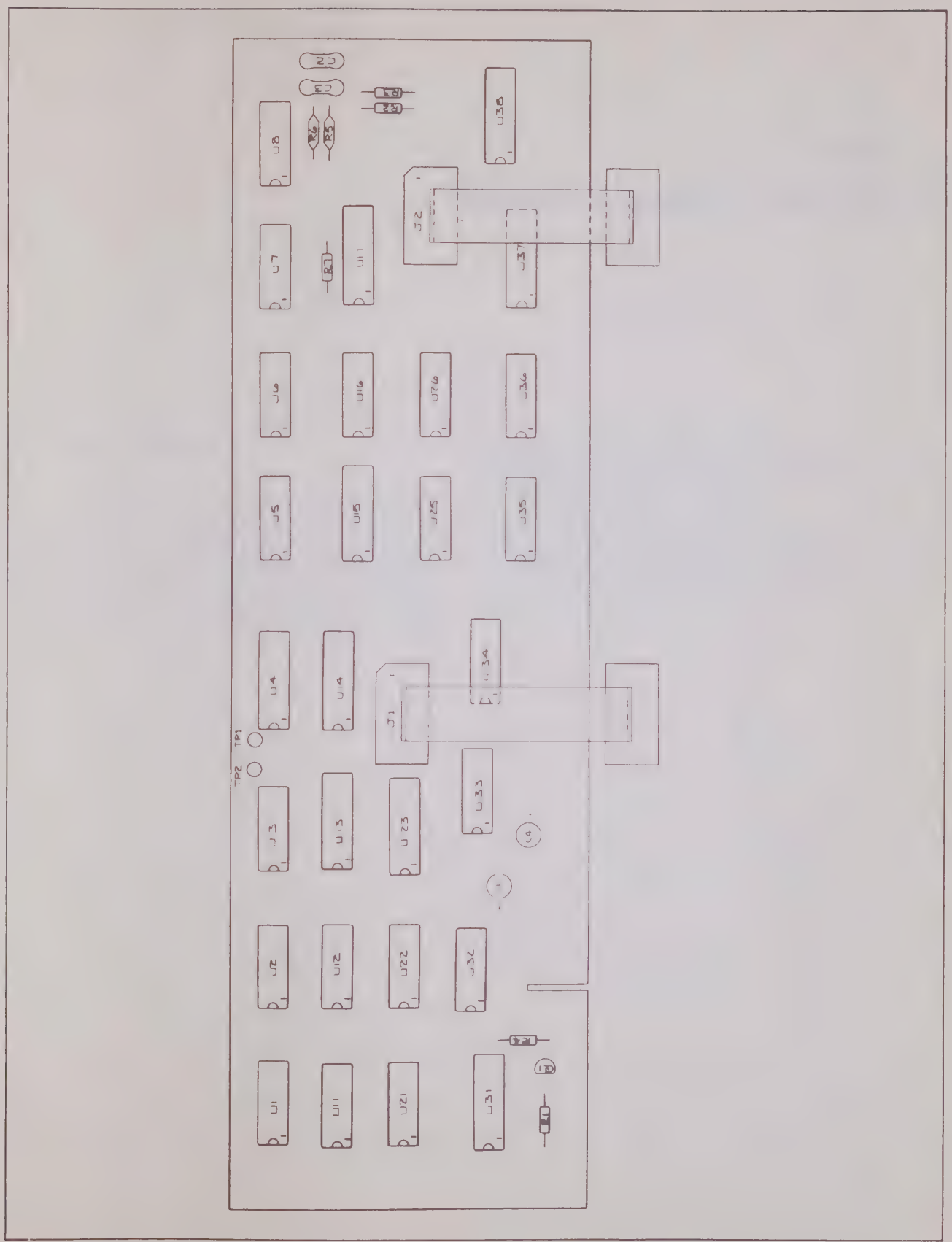


Figure 5-11. A10A2, Fast R² A/D Converter (Digital)

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual employs modular construction. Information relating to accessories for the 8500A is included first. Page and paragraph numbering for accessories is a 600-X series where X is the page or paragraph number. Optional modules ordered with your instrument will be covered in modular subsections included in your manual. Page and paragraph numbering is a 6YY-X series where YY is the option number (–01, –02, –17, etc.) and X is the page or paragraph number.

6-3. As you expand your 8500A system, manual subsections covering the option you order will be included with the option. This assures the most up-to-date information. Additional subsections can easily be added to this section.

TABLE OF CONTENTS

OPTION/ MODEL NO.	DESCRIPTION	DOCUMENTATION SUPPLIED:	PAGE NO.
	ACCESSORIES		
M04-205-600	Rack Ear Mounting Assembly	Herein	600-1
80F-5	High Voltage Probe	Herein	600-1
80F-15	High Voltage Probe	Herein	600-2
81RF	High Frequency Probe	Herein	600-2
82RF	High Frequency Probe	Herein	600-2
KDM1	Keyboard Display Module	Herein	600-2
	OPTIONS		
–01	AC/DC Converter (Averaging)	With Option	601-1
–02	Ohms Converter	With Option	602-1
–03	Current Shunts	With Option	603-1
–04	Calibration Memory	With Option	604-1
–05	IEEE Standard 488-1975 Interface	With Option	605-1
–06	Bit Serial Asynchronous Interface	With Option	606-1
–07	Parallel Interface	With Option	607-1
–08	Isolator	With Option	608-1
–09	AC/DC Converter (RMS)	With Option	609-1
–17	Rear Input	With Option	617-1

Accessories

600-1. RACK EAR MOUNTING ASSEMBLY

600-2. Figure 600-1 illustrates installation of the Rack Ear Mounting Assembly. Use the following procedure.

1. Remove the nameplate decals from handles.
2. Remove the screws from handles.
3. Attach rack ears with # 8 - 32 x 5/8 PHP screws (enclosed in kit).
4. Remove the front screws from top and bottom cover which match the hole pattern in trim items.
5. Attach trim angle on top cover and trim channel on bottom cover with # 6 - 32 x 3/8 PHP screws and lock washer (enclosed in kit).

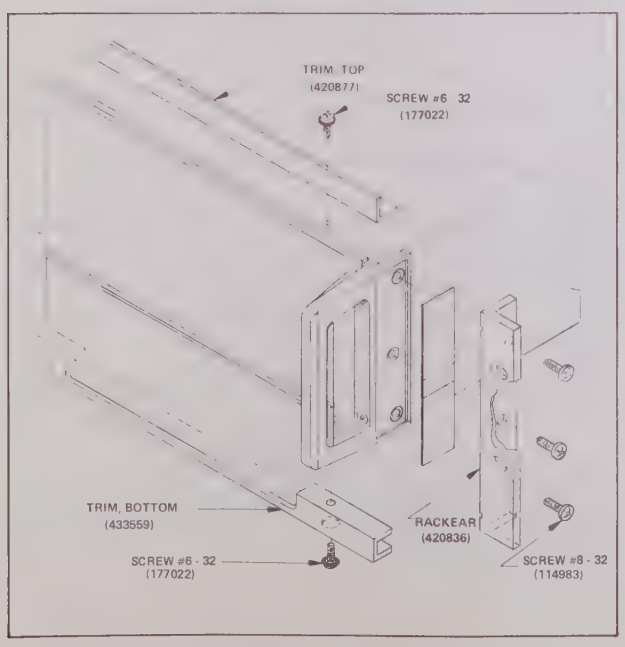


Figure 600-1. Rack Ear Mounting Installation

600-3. HIGH VOLTAGE PROBE (80F-5)

600-4. The Model 80F-5 Voltage Divider shown in Figure 600-2 allows measurement of up to 5k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

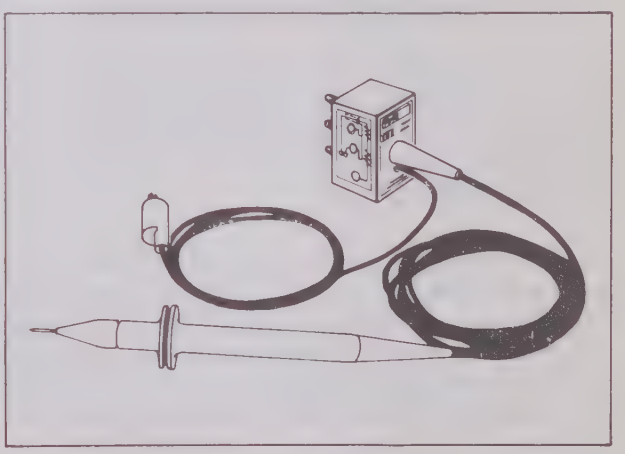


Figure 600-2. 80F5 Voltage Divider

600-5. Physical design of the Model 80F-5 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-6. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided

for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohms or greater) at null.

600-7. HIGH VOLTAGE PROBE (80F-15)

600-8. The Accessory Model 80F-15 Voltage Divider, shown in Figure 6-7, allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

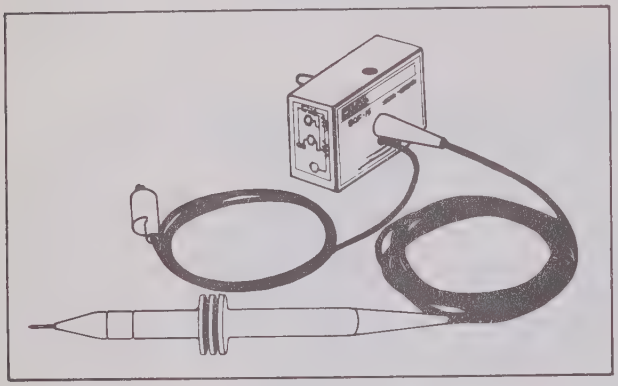


Figure 600-3. 80F15 Voltage Divider

600-9. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-10. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

600-11. HIGH FREQUENCY PROBE (81 RF)

600-12. The Model 81RF High Frequency Probe, Figure 600-4, extends the frequency range of the DVM/DMM to include 100 kHz to 100 MHz for ac voltage measurements from 0.25 to 30V rms. The 81RF operates in conjunction with the dc voltage ranges, and is connected to the DVM DMM using a shielded dual-banana plug and, when necessary, a dual banana adaptor.

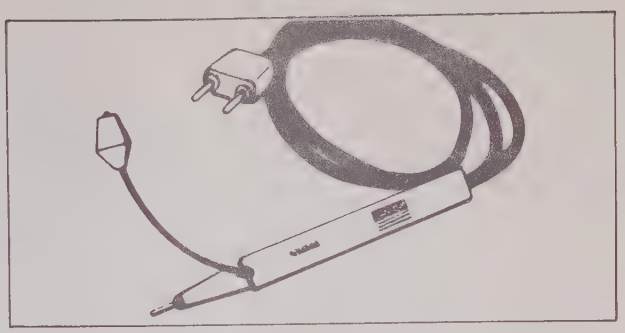


Figure 600-4. 81RF High Frequency Probe

600-13. HIGH FREQUENCY PROBE (82RF)

600-14. The Model 82RF High Frequency Probe, Figure 600-5, allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30V rms. It is designed to be used with voltmeters having an input impedance of 10 megohms + 10%. It may be used with a voltmeter having an input impedance higher than 10 megohms provided the input is externally shunted to make the equivalent input impedance equal to 10 megohms.

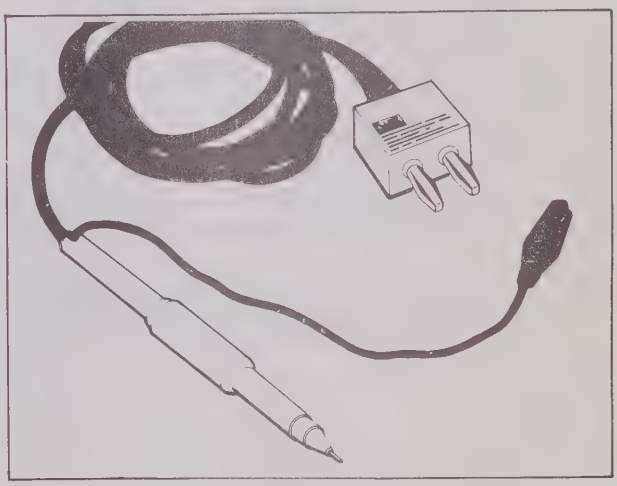


Figure 600-5. 82RF High Frequency Probe

600-15. Circuitry within the 82RF consists of a capacitor-coupled rectifier circuit which responds to the peak value of the input waveform. The output is positive polarity dc which is calibrated to be equivalent to the rms value of a sine wave.

600-16. KEYBOARD DISPLAY MODULE (KDM1)

600-17. The Micon KDM1 Keyboard Display Module is a LED display terminal (with a connecting cable) for use with the Bit Serial Asynchronous Interface (Option –06). Standard ASCII characters are used on the keyboard to facilitate programming the 8500A.

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable parts contained in Section 5. The following information is presented in this section:

List of Abbreviations
Federal Supply Codes for Manufacturers
Fluke Technical Service Centers — U.S. and Canada
Sales and Service Locations — International
Sales Representatives — U.S. and Canada

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
^{o}C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
^{o}F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^{9})
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^{3})
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^{6})
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(–) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers (Continued)

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisberg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884 - use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571 - use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
Ross Milton, Co., The
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Division
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, MA

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933 - use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept.
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988 - use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, MN

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

Federal Supply Codes for Manufacturers (Continued)

11711
General Instrument Corp
Rectifier Division
Hickville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Division
AMF Canada LTD.
Guelph, Onatrio, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
Budd Co. The, Polychem Products
Plastic Products Div.
Bridgeport, PA

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606 - use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors, formerly
Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
G T E Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co. Corporate H.Q.
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
A B Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
Mallory, P.R. & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp, formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, Californai

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnbach Radio Co., Inc.
Freeport, LI New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village, Chicago, Illinois

72005
Driver, Wilber B., Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrence, California

73445
Amperex Electronic Corp.
Hicksville, LI, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp., Mepco Div.
A North American Phillips Co.
Morristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183 - use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Stevens, Arnold Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81439
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
Carr Co., The United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330
Smith, Herman H., Inc.
Brooklyn, New York

83478
Rubbercraft Corp. of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products,
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co. Div of
P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211 - use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737 - use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154 - use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic Hdware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect. Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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Fluke Technical Center
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Tel. (514) 670-1212

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B-1040 Brussels, Belgium
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Tel. 66121

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Ballerup Byveg 222
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Tel. (01) 2-65 81 11

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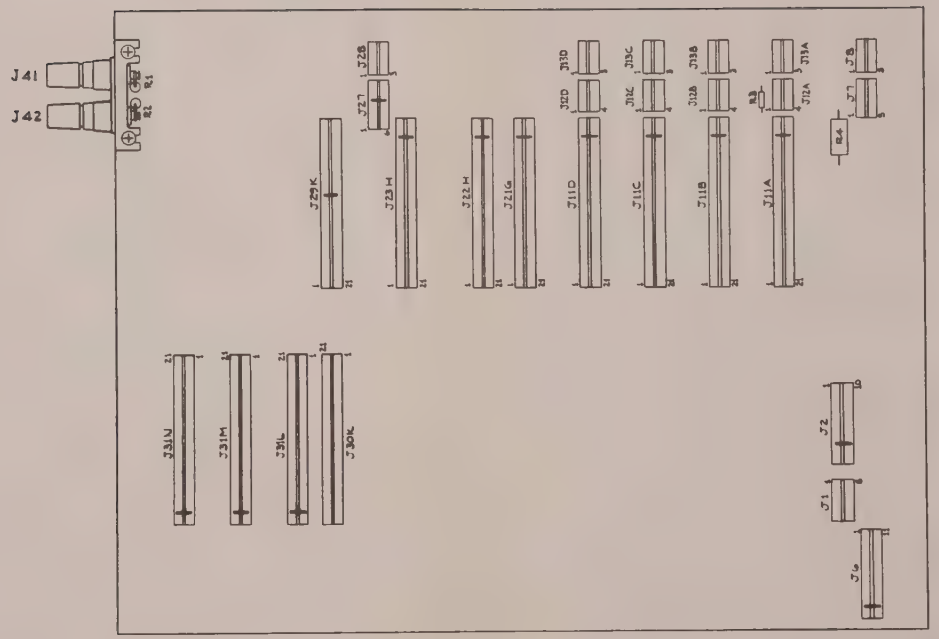
Section 8
Schematic Diagrams

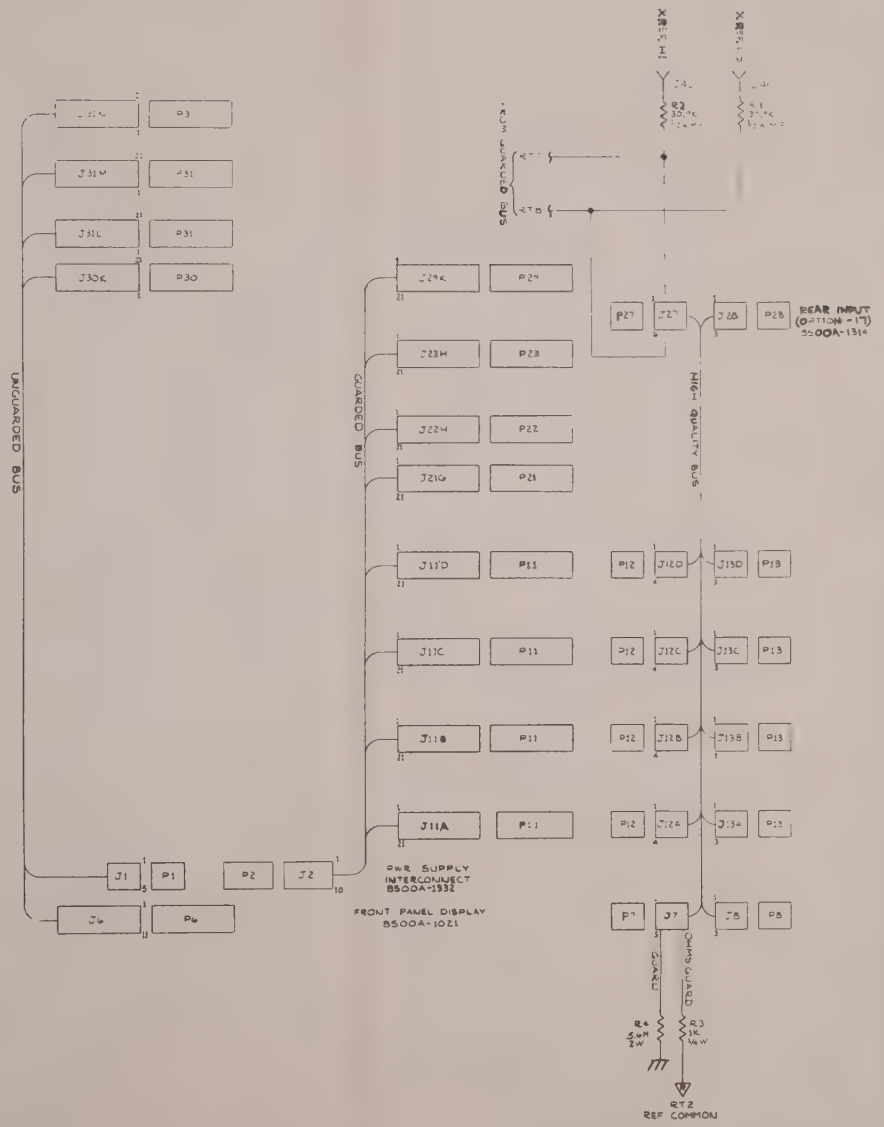
FIGURE NO.	NAME	DRAWING NO.	PAGE
8-1	Reference Designation, Motherboard PCB Assembly	8500A-1601	8-3
8-2	Interconnect Diagram (2 Sheets)	8500A-1301	8-4
8-3	Mother Board Interconnect	8500A-1001	8-6
8-4	Bus Interconnect	M.I.S.-1081	8-7
8-5	Reference Designation, Power Supply	8500A-1631	8-8
8-6	Power Supply	8500A-1041	8-9
8-7	Power Supply Interconnect	8500A-1332	8-10
8-8	Reference Designation, Controller	M.I.S.-1785	8-11
8-9	Controller (2 Sheets)	M.I.S.-1185	8-12
8-10	Reference Designation, Front Panel Display Assembly	8500A-1621	8-14
8-1	Front Panel	8500A-1021-D	8-15
8-12	Reference Designation, D.C. Signal Cond. Assembly	M.I.S.-1700	8-16
8-13	M.I.S. D.C. Signal Conditioner	M.I.S.-1100-D	8-17
8-14	Reference Designation, Active PCB Assembly	M.I.S.-1730	8-18
8-15	Active Filter/External Reference	M.I.S.-1130	8-19
8-16	Reference Designation, Fast R^2 A/D Converter (Digital)	M.I.S.-1741	8-20
8-17	Reference Designation, Fast R^2 A/D Converter (Analog)	M.I.S.-1740	8-21
8-18	Fast R^2 A/D (Digital)	M.I.S.-1141	8-22
8-19	Fast R^2 A/D (Analog)	M.I.S.-1140	8-23



NOTES:

1. FOR ASSY DRAWING SEE 8500A-4001
2. FOR PCB SEE 8500A-3001
3. FOR SCHEMATIC SEE 8500A-1001
4. FOR INTERCONNECT DIAGRAM SEE 8500A-1301

Figure 8-1. Reference Designation, Motherboard PCB Assembly (8500A-1601)



MODULE INSTALLATION LOCATIONS			
MODULE DESCRIPTION	SCHEMATIC DWG NO.	PREFERRED SLOT	PERMISSABLE SLOTS
D.C. SIGNAL COND		A	A B C D
AC AVG. CONV (OPTION -01)		B	A B C D
R M S CONV (OPTION -09)		B	A B C D
CURRENT SHUNT (OPTION -03)		C	A B C D
OHMS CONV (OPTION -02)		D	A B C D
FILTER		G	G
A/C CONV		H	H
BUS INTERCONNECT		F	F
[illegible] (OPTION -08)		F	F
CONTROLLER	M.I.S.-1185	N (WHEN I/O NOT INSTALLED)	L M N
CALIBRATION MEMORY (OPTION -04)		M	L M N
BIT SERIAL (OPTION -06)		N	L M N
PARALLEL INTERFACE (OPTION -07)		N	L M N
IEEE INTERFACE (OPTION -05)		N	L M N

SERVICE / FIELD AIDS - LOCATIONS			
DESCRIPTION	SCHEMATIC DWG NO.	PREFERRED SLOT	PERMISSABLE SLOTS
STATIC CONTROLLER M.I.S. 7190K	M.I.S. 1190	L M N	A B C D L M N
TEST MODULE M.I.S.-7191K	M.I.S.-1191	A B C D	A B C D L M N
EXTENDER M.I.S.-7011K		NONE	ANY
BUS INTERCONNECT & MONITOR M.I.S. 7011K		F	ANY

NOTES:
1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1601
2. FOR REF. DES. DRAWING SEE M.I.S.-1601
3. FOR ASSY. DRAWING SEE M.I.S.-4001

Figure 8-2. Interconnect Diagram (8500A-1301)

(Sheet 1 of 2)

FUNCTION TABLE

CONNECTOR	PIN NO.	FUNCTION
J1 (Unguarded Bus)	1	+12V Vdd
	2	Vss Logic Return
	3	N.
	4	+15V Vcc
	5	RT5 (Line Freq. Ref.)
	6	-12V Vgg
	7	Vss Logic Return
	8	+5V Vcc
J2 (Guarded Bus)	1	-15V Vcc Logic Supply
	2	-20V Vss Logic Return
	3	AR Analog Return
	4	-15V VA2
	5	-30V VA4
	6	NC
	7	NC
	8	NC
	9	Guard
	10	-15V Vcc Logic Supply
	11	-20V Vss Logic Return
	12	AR Analog Return
	13	+15V VA1
	14	+30V VA3
	15	NC
	16	NC
	17	NC
	18	Guard
J6 (Unguarded Bus)	1	Vss (Logic Return)
	2	ACK (Acknowledge)
	3	+5V Vcc
	4	IC5 (Interbus Control)
	5	IC3 (Interbus Control)
	6	IC1 (Interbus Control)
	7	ID7 (Interbus Data)
	8	ID5 (Interbus Data)
	9	ID3 (Interbus Data)
	10	ID1 (Interbus Data)
	11	Vss (Logic Return)
	12	+5V Vcc
	13	IC6 (Interbus Control)
	14	IC4 (Interbus Control)
	15	IC2 (Interbus Control)
	16	IC0 (Interbus Control)
	17	ID6 (Interbus Data)
	18	ID4 (Interbus Data)
	19	ID2 (Interbus Data)
	20	ID0 (Interbus Data)
J7 (High Quality Bus)	1	Guard
	2	Input Lo
	3	Source Lo
	4	Ohms Guard
	5	Guard
	6	Input Lo
	7	Source Lo
	8	Ohms Guard
J8 (High Quality Bus)	1	Source Hi
	2	Input Hi
	3	Source Hi
	4	Input Hi
J11A, J11B, J11C, J11D (Guarded Bus)	1	Guard
	2	RT0 (Ohm's Guard)
	3	RT2 (Ref. Common)
	4	RT4 (Ref. -7V, A/D to Ohm's Conv.)
	5	RT6 (DC, AMP., AC, Avg., & AC, RMS, Output ÷A/F, Input)
	6	RT8 (X, Ref, Lo.)
	7	-30V VA4
	8	-15V VA2
	9	AR (Analog Return)
	10	INT (Interupt not)
	11	-20V Vss (Logic Return)
	12	-15V Vcc (Logic Supply)
	13	IC6 (Interbus Control)
	14	IC4 (Interbus Control)
	15	IC2 (Interbus Control)
	16	IC0 (Interbus Control)

FUNCTION TABLE

NN...	N...	FUNCTION
J11A, J11B, J11C, J11D (Guarded Bus)	-	ID6 Interbus Data
	4	ID4 Interbus Data
	9	ID2 Interbus Data
	13	ID0 Interbus Data
	-	Guard
	-	RT0 Ohms Guard
	23	RT1 Ohms + Current Output HI +DC AMP., AC Avg., & AC RMS, Input HI
	24	RT3 AC Avg., & RMS Input Lo ÷ Current Output Lo
	25	RT5 A/D Input & A/F Output
	26	RT7 X Ref Hi
	27	+10V VA3
	28	+15V VA1
	29	INA Interupt Acknowledge
	30	AR Analog Return
	1	-20V Vss Logic Return
	32	ACK Acknowledge
	33	-15V Vcc Logic Supply
	34	IC5 Interbus Control
	35	IC3 Interbus Control
	36	IC1 Interbus Control
	37	ID7 Interbus Data
	38	ID5 Interbus Data
	39	ID3 Interbus Data
	40	ID1 Interbus Data
J12A, J12B, J12C, J12D (High Quality Bus)	1	Input Lo
	2	Source Lo
	3	Ohms Guard
	4	Input Lo
	5	Source Lo
	6	Ohms Guard
J13A, J13B, J13C, J13D (High Quality Bus)	1	Source HI
	2	Input HI
	3	Source HI
	4	Input HI
J27 (High Quality Bus)	1	Guard
	2	X Ref HI
	3	Input Lo
	4	Source Lo
	5	Ohms Guard
	6	Guard
	7	X Ref Lo
	8	Input Lo
	9	Source Lo
	10	Ohms Guard
J28 (High Quality Bus)	1	Source HI
	2	Input HI
	3	Source HI
	4	Input HI
J29G, J29H, J29M, J29K (Guarded Bus)	1	Guard
	2	RT0 Ohms Guard
	3	RT2 Ref Common
	4	RT4 Ref -7V A/D to Conv
	5	RT6 DC, AMP, AC Avg., & AC RMS Output ÷A/F, Input
	6	RT8 X Ref Lo
	7	-30V VA4
	8	-15V VA2
	9	AR Analog Return
	10	INT Interupt not
	11	-20V Vss Logic Return
	12	-15V Vcc Logic Supply
	13	IC6 Interbus Control
	14	IC4 Interbus Control
	15	IC2 Interbus Control
	16	IC0 Interbus Control
	17	ID6 Interbus Data
	18	ID4 Interbus Data
	19	ID2 Interbus Data
	20	ID0 Interbus Data

FUNCTION TABLE

CONNECTOR	PIN NO	FUNCTION
J21G, J22H, J23M, J29K (Guarded Bus)	21	Guard
	22	RT0 Ohms Guard
	23	11
	24	RT1 AC Avg., RMS Input Lo ÷ Current O Input Lo.
	25	RT5 A/D, Input & A/F, Output
	26	RT7 X Ref HI
	27	+10V VA1
	28	+15V VA1
	29	INA Interupt Acknowledge
	30	AR Analog Return
	31	-20V Vss Logic Return
	32	ACK Acknowledge
	33	-15V Vcc Logic Supply
	34	IC5 Interbus Control
	35	IC3 Interbus Control
	36	IC1 Interbus Control
	37	ID7 Interbus Data
	38	ID5 Interbus Data
	39	ID3 Interbus Data
	40	ID1 Interbus Data
J30K, J31M, J31M, J31L (Unguarded Bus)	1	Guard Logic Common
	2	RT0 Real Time 0
	3	RT2 Real Time 2
	4	RT4 Real Time 4
	5	RT6 Real Time 6
	6	Vgg 12
	7	NC
	8	NC
	9	NC
	10	INT Interrupt not
	11	Vss Logic Return 12
	12	Vcc 12
	13	IC6 Interbus Control
	14	IC4 Interbus Control
	15	IC2 Interbus Control
	16	IC0 Interbus Control
	17	ID6 Interbus Data
	18	ID4 Interbus Data
	19	ID2 Interbus Data
	20	ID0 Interbus Data
	21	Guard Logic Common
	22	RT0 Real Time 0
	23	RT1 Real Time 1
	24	RT3 Real Time 3
	25	RT5 Line Freq. Ref
	26	Vdd 12
	27	NC
	28	NC
	29	INA Interrupt Acknowledge
	30	NC
	31	Vss Logic Return 12
	32	ACK Acknowledge
	33	Vcc 12
	34	IC5 Interbus Control
	35	IC3 Interbus Control
	36	IC1 Interbus Control
	37	ID7 Interbus Data
	38	ID5 Interbus Data
	39	ID3 Interbus Data
	40	ID1 Interbus Data

Notes

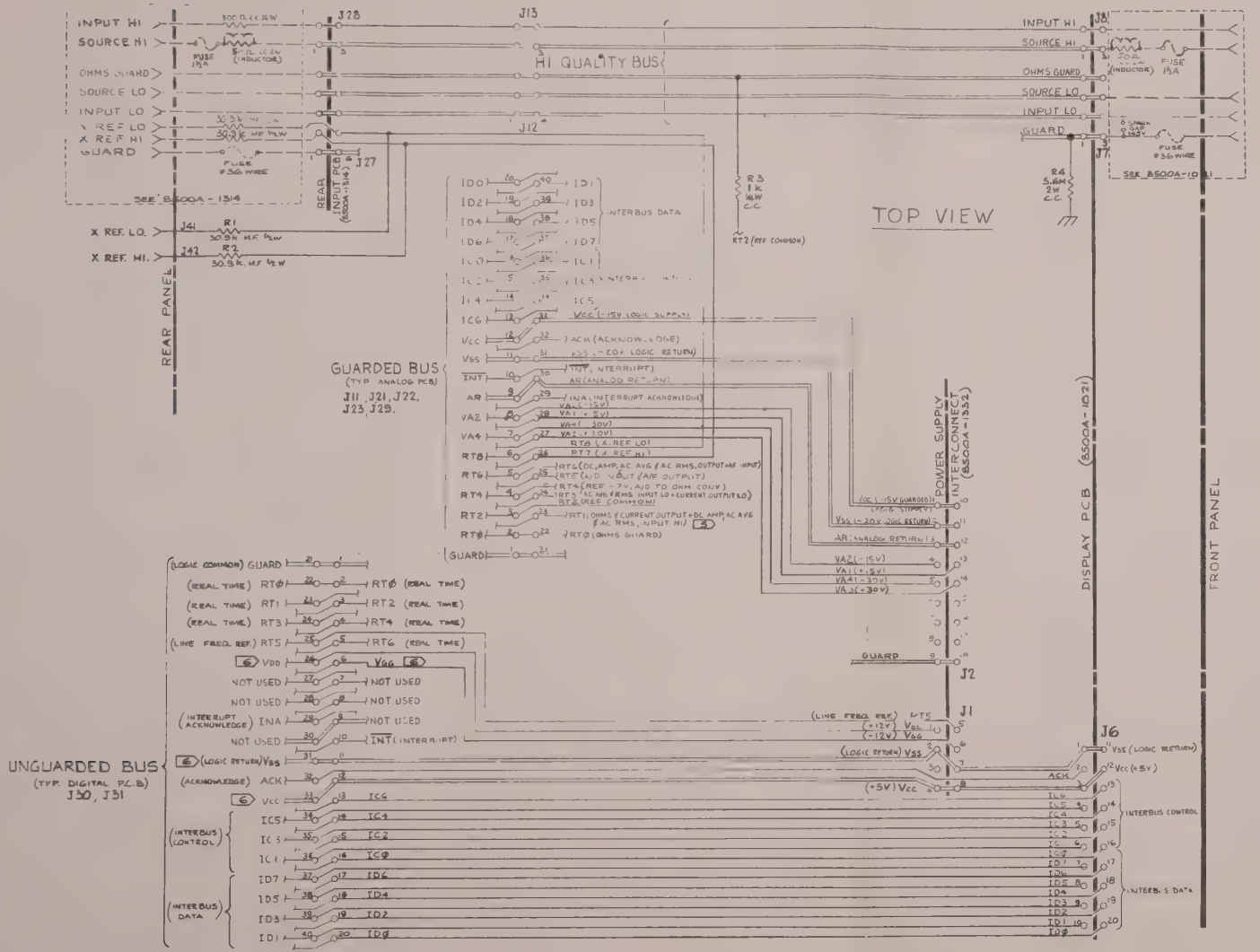
11 This Bus line is not used for 8500A applications, but it is interconnected on J21G, J22H, J23M, & J29K. No connection is made with J11 Pin 23.

12 Functions will vary depending upon type of Bus Interconnection installed in unit.

Function	Isolator (option-08)	Bus Interconnect (#15408I)
Vss	0	-20V
Vdd	+12V	-8V
Vgg	-12V	-32V
Vcc	+5V	-15V

Figure 8-2. Interconnect Diagram (8500A-1301)

(Sheet 2 of 2)

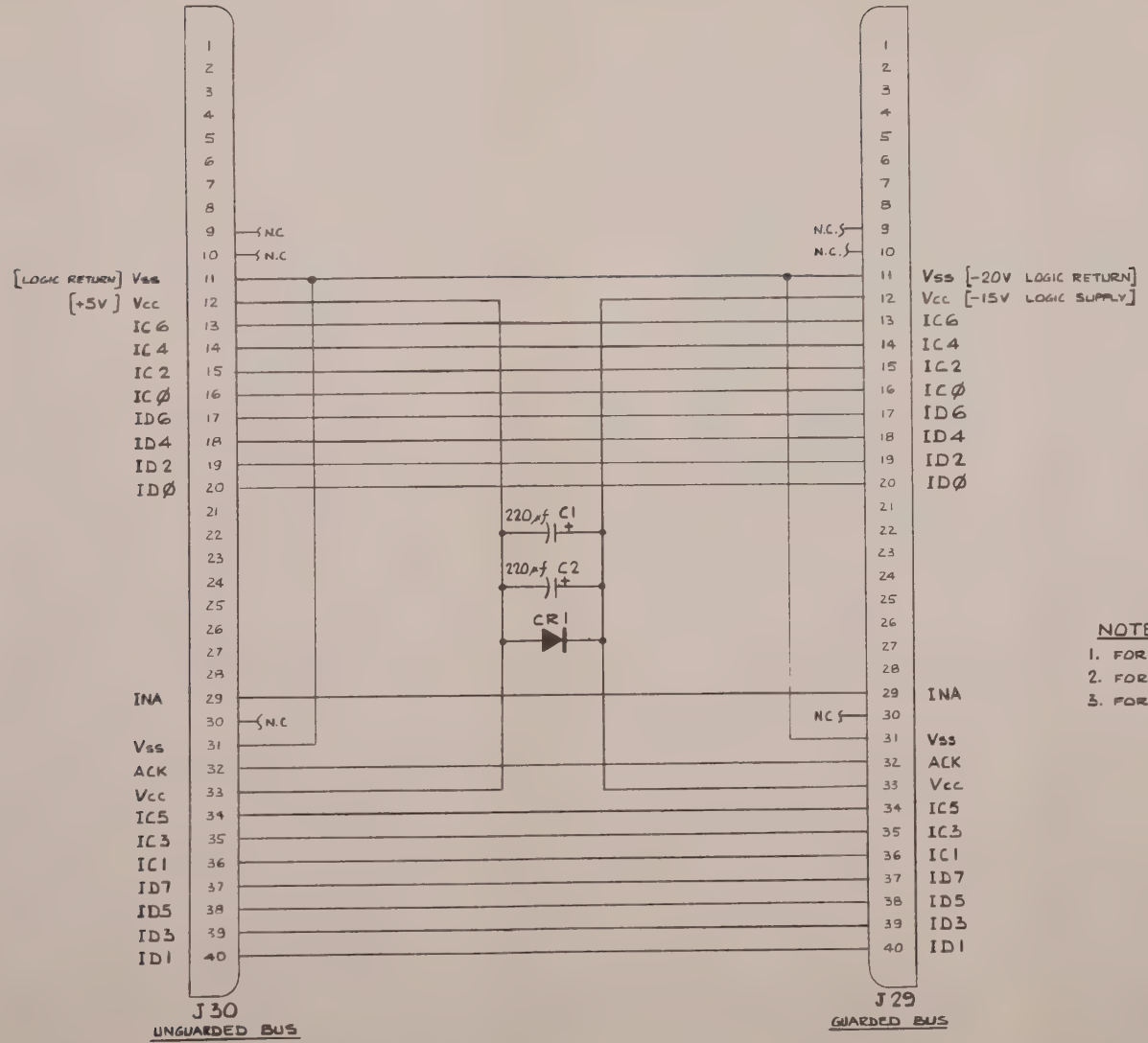


NOTES:

1. FOR MOTHER PCB SEE 8500A-3001.
2. FOR MOTHER ASSY SEE 8500A-4001
3. FOR REF. DES DWG SEE 8500A-1601
4. FOR INTERCONNECT DIAGRAM SEE 8500A-1301
5. THIS BUS LINE IS INTERCONNECTED ON J21 J22 J23 & J29 BUT HAS NO USE ON 8500A APPLICATIONS IN THESE LOCATIONS. FUNCTION INDICATED IS FOR J11 ONLY. NO INTERCONNECT EXISTS BETWEEN J11, & J23 & OTHER CONNECTORS ON GUARDED BUS.
6. FUNCTIONS WILL VARY DEPENDING UPON BUS INTERCONNECTION INSTALLED IN UNIT.

FUNCTION	ISOLATOR (OPTION -08)	BUS INTERCONNECT (MIS-1084)
V_{33}	0	-20V
V_{AD}	+12V	-8V
V_{GG}	-12V	-32V
V_{CC}	+5V	-15V

Figure 8-3. Mother Board Interconnect (8500A-1001)



NOTES:

1. FOR P.C.B. SEE M.I.S.-3081
2. FOR ASSY SEE M.I.S-4081
3. FOR REF. DES. SEE M.I.S.-1681

Figure 8-4. Bus Interconnect (M.I.S.-1081)

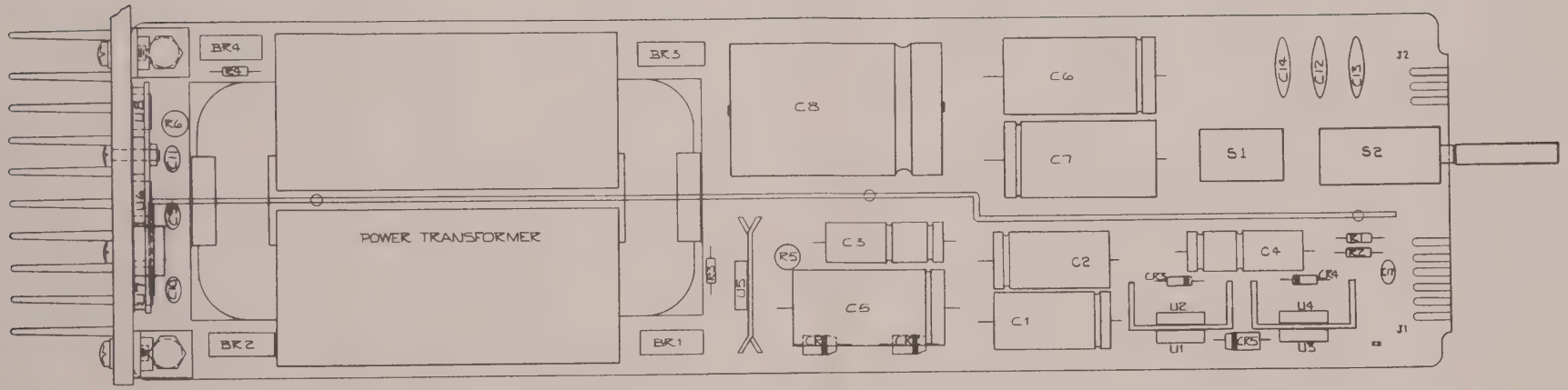


Figure 8-5. Reference Designation, Power Supply

(8500A-1631)

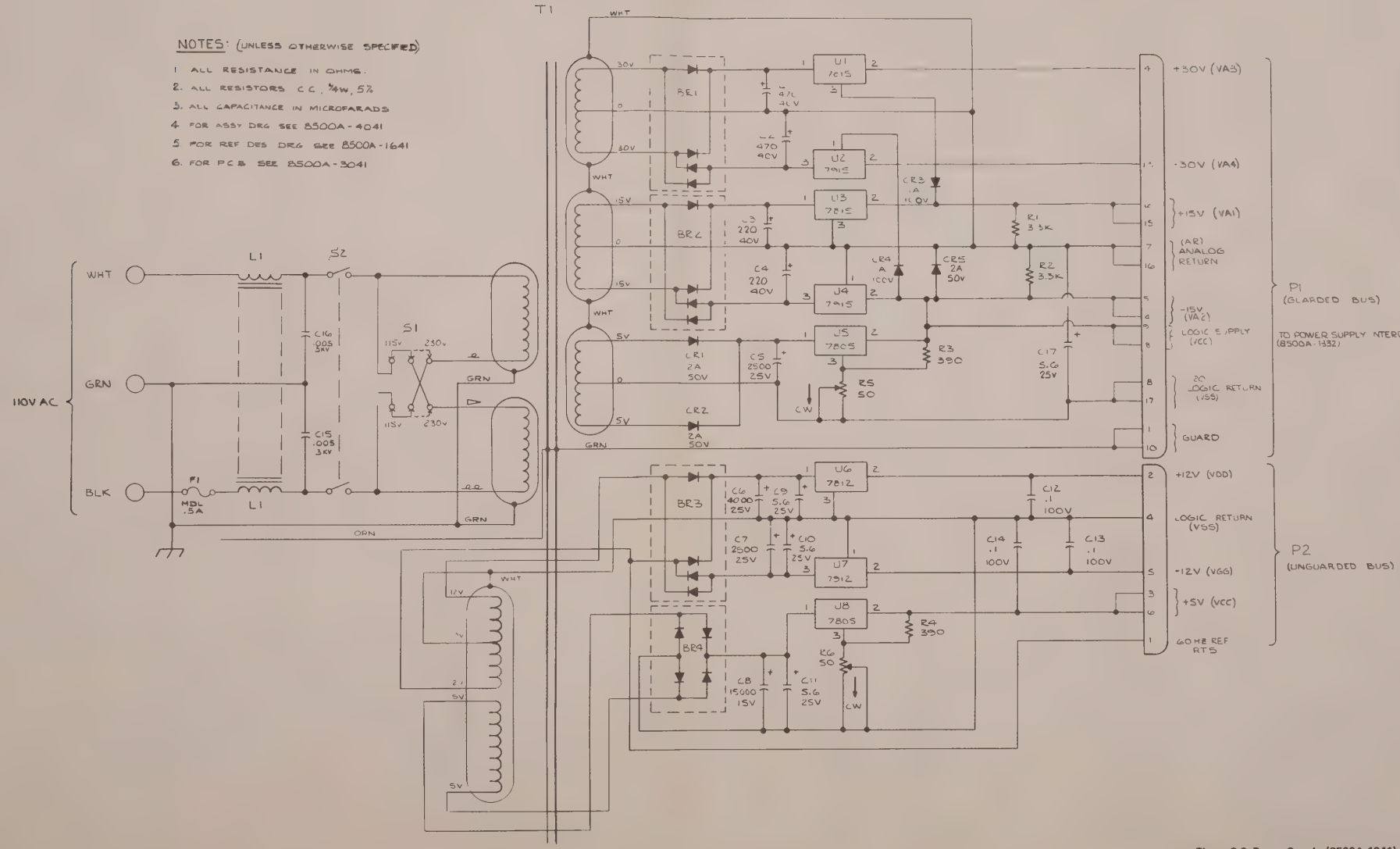


Figure 8-6. Power Supply (8500A-1041)

NOTES:

1. FOR P.C.B. SEE 8500A-3032.
2. FOR ASSY. SEE 8500A-4032.
3. FOR PWR SUPPLY SCHEMATIC SEE 8500A-1041
4. FOR MOTHER INTERCONNECT DIAGRAM SEE 8500A-1301.

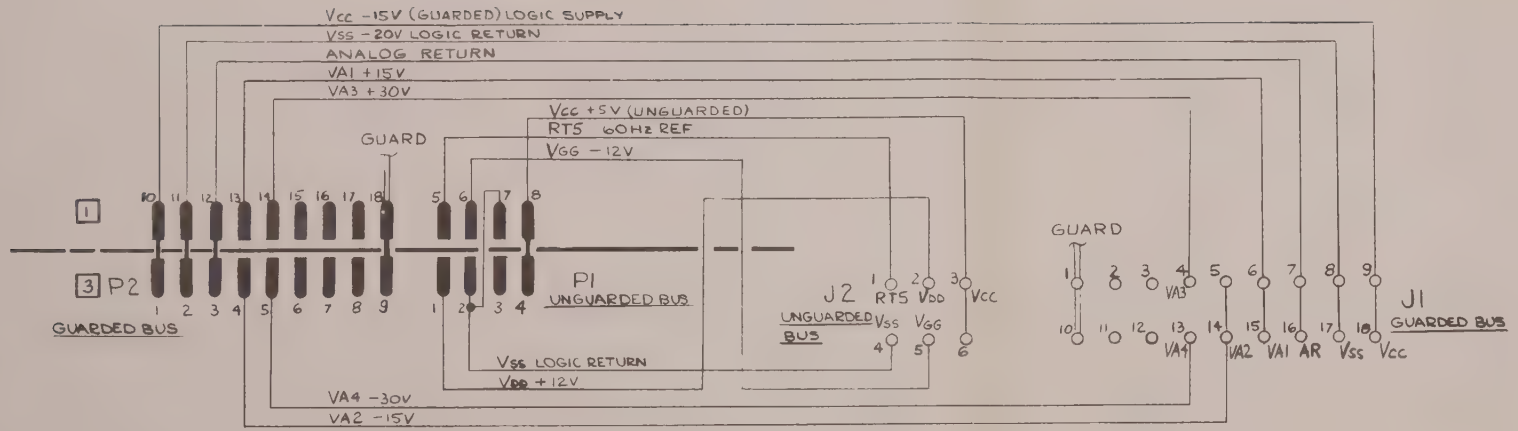


Figure 8-7. Power Supply Interconnect (8500A-1332)

ACK	– acknowledge
ACK LAT	– acknowledge late
AR	- analog return
DB	– data bus
DBIN	- data bus input signal (from μP)
DLD ACK	– delayed ACK
EN INT	– enable interrupt
HLDA	– hold acknowledge
IB ADX	– interbus address
IBIN	– interbus input signal
IC	– interbus control
ID	interbus data
IINT	– internal interrupt
INA	– interrupt acknowledge (from controller)
INT	– interrupt
INTA	– Interrupt acknowledge (status word from μP)
INTE	– interrupt enable (from μP)
MEM RD	– memory read
MS ADDR BYTE	– memory select address byte
$\phi 1$	- clock pulse
$\phi 2$	– clock pulse
ϕLL	– phase-locked loop
RAM	– random access memory
ROM	– read only memory
RRDY	– reset ready
RST	– reset
RT	– real time
R/W	– read/write
μP	– microprocessor
VA	- analog supply voltage
V_{CC} $\phi 2$	– 5V clock pulse
V_{DD} $\phi 2$	– 12V clock pulse
SRDY	– set ready
SYN IINT	– synchronized internal interrupt
TTL PU	– TTL pull-up
WO	– write out
WR	– write

NOTES:

1. FOR ASSEMBLY DWG SEE MIS-4185.
2. FOR PCB SEE MIS-3185
3. FOR SCHEMATIC SEE MIS-1185.

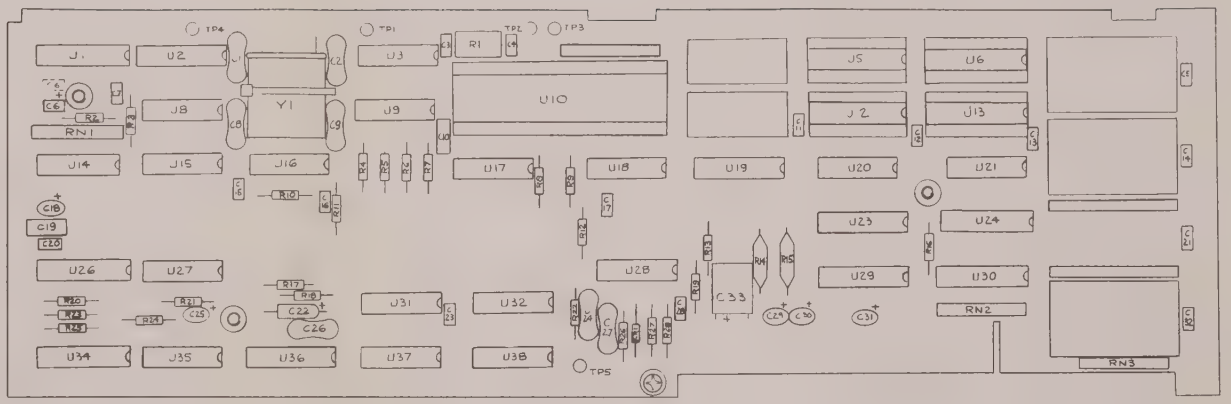
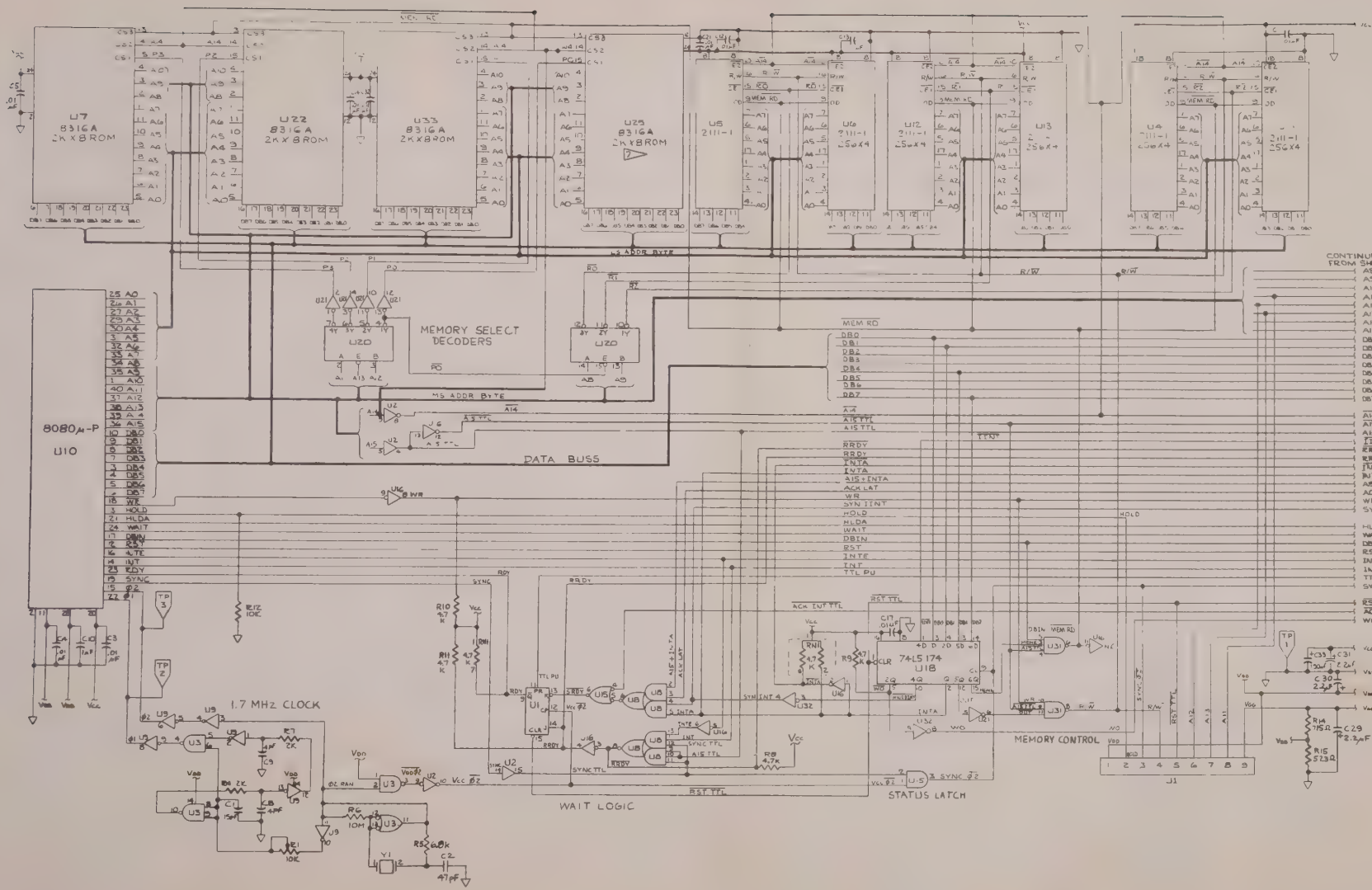


Figure 8-8. Reference Designation Controller (M.I.S.-1785)


U7 8316A 2KX8ROM
U22 8316A 2KX8ROM
U33 8316A 2KX8ROM
U25 8316A 2KX8ROM
U5 2111-1
U6 2111-1 256X4
U12 2111-1 256X4
U13 256X4
U4 2111-1 256X4
2111-1 256X4
MS ADDR BYTE
R/W
CONTINUED FROM SHEET 1
MEMORY SELECT DECODERS
U20
U21
8080A-P
U10
DATA BUSS
MEM RD
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
A14
A15 TTL
A15 TTL
INT
RRDY
RRDY
INTA
INTA
A15+INTA
ACK LAT
WR
SYN INT
HLDA
WAIT
DBIN
RST
INTE
INT
TTL PU
SYNC Ø2
RST TTL
ACK INTTTL
WO
HOLD
MEMORY CONTROL
J1
1.7 MHz CLOCK
WAIT LOGIC
STATUS LATCH
74LS174
U18
U31
U32
U33
U34
U35
U36
U37
U38
U39
U40
U41
U42
U43
U44
U45
U46
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U61
U62
U63
U64
U65
U66
U67
U68
U69
U70

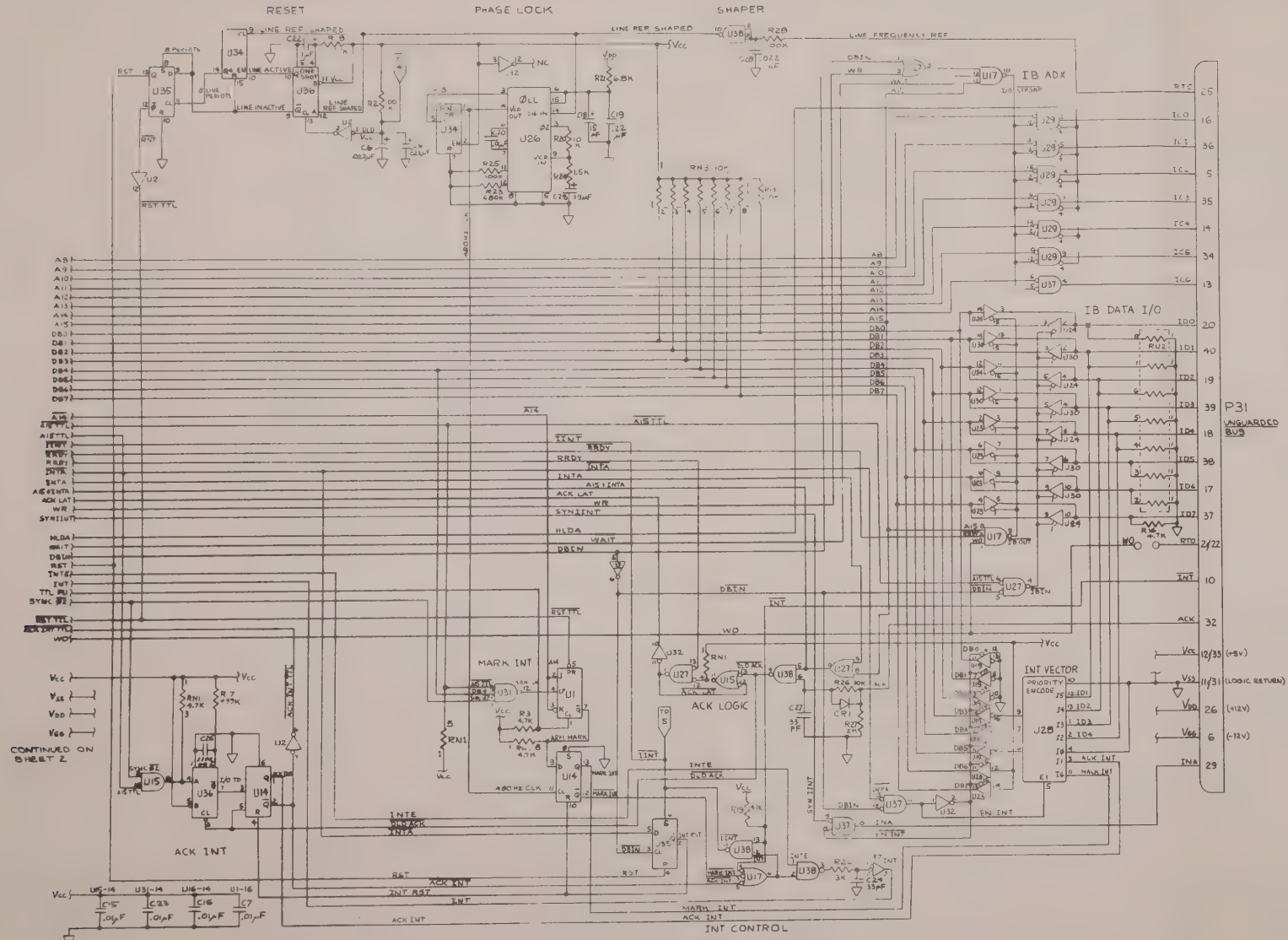


Figure 8-9. Controller (M.I.S.-1185) (Sheet 2 of 2)

NOTES:
1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1121
2. FOR P.C.B. SEE M.I.S.-3021
3. FOR ASSEMBLY SEE M.I.S.-4021

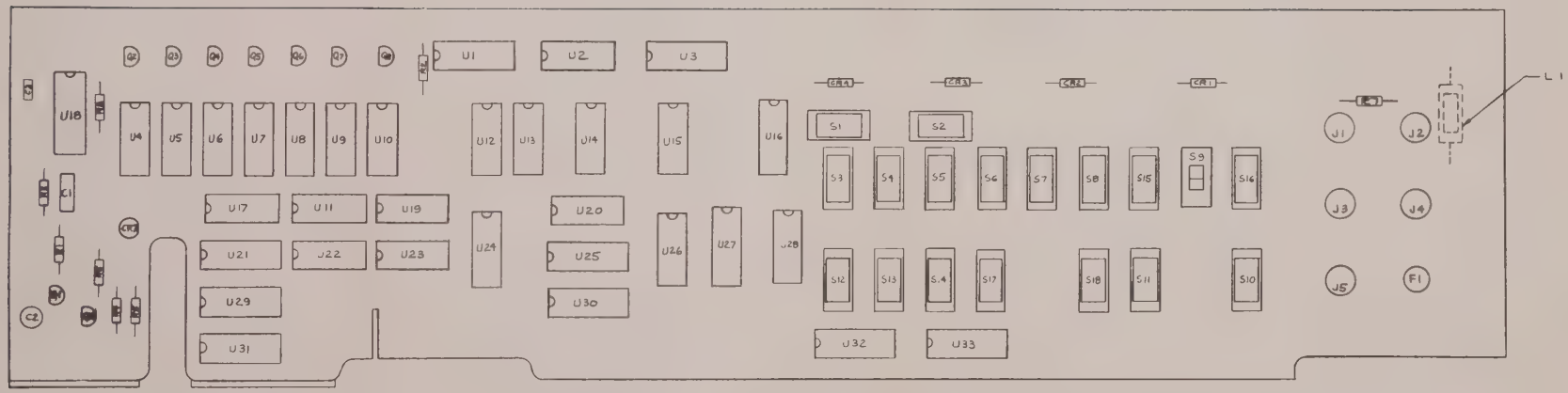


Figure 8-10. Reference Designation,
Front Panel Display Assembly (8500A-1621)

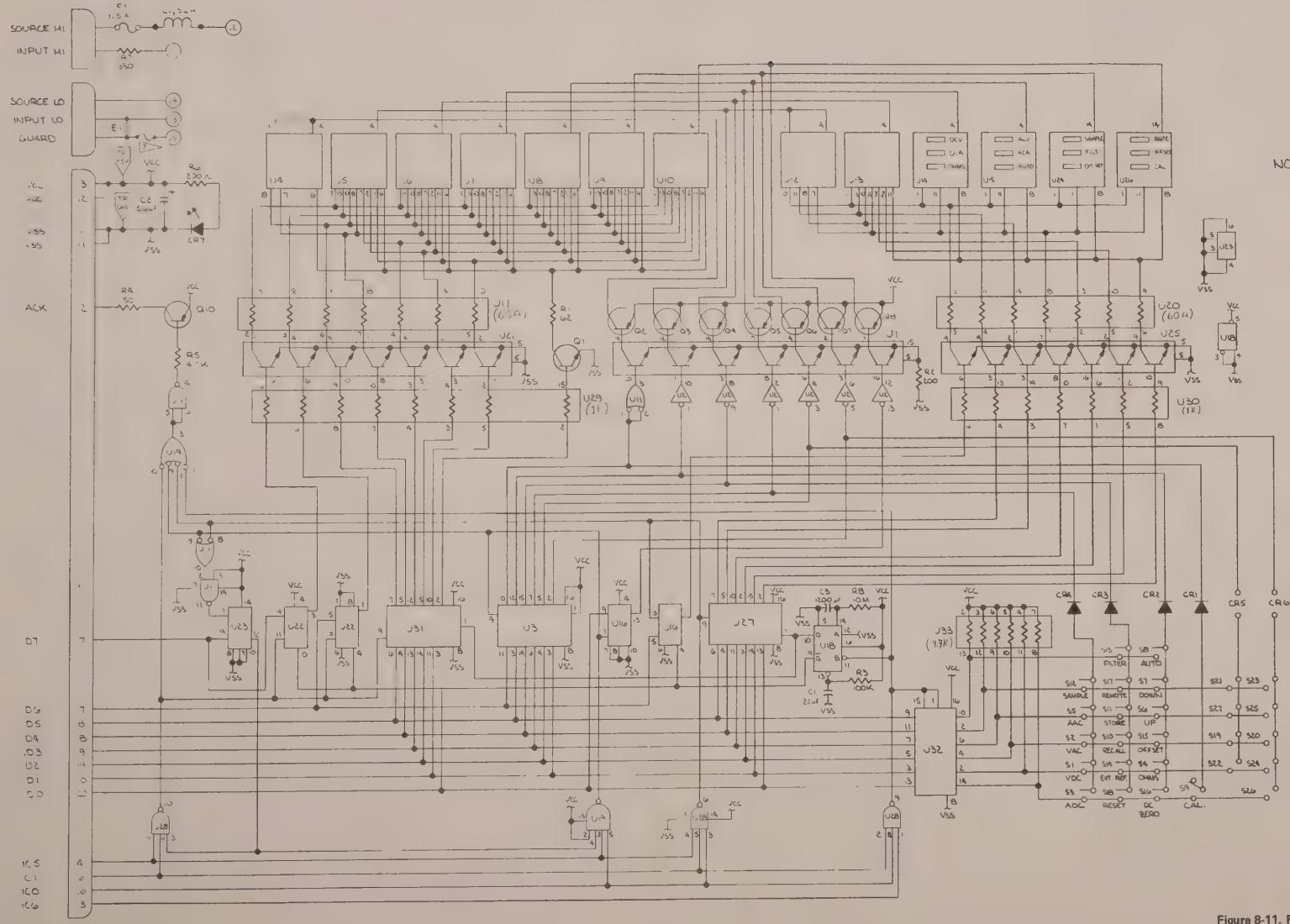


Figure 8-11. Front Panel (8500A-1021-D)

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1100
2. FOR P.C.B. SEE M.I.S.-3100
3. FOR ASSY. DRG. SEE M.I.S.-4100
4. R54, R55, R56 & R57 WILL BE DETERMINED DURING TESTING. RESISTORS MAY BE INSTALLED

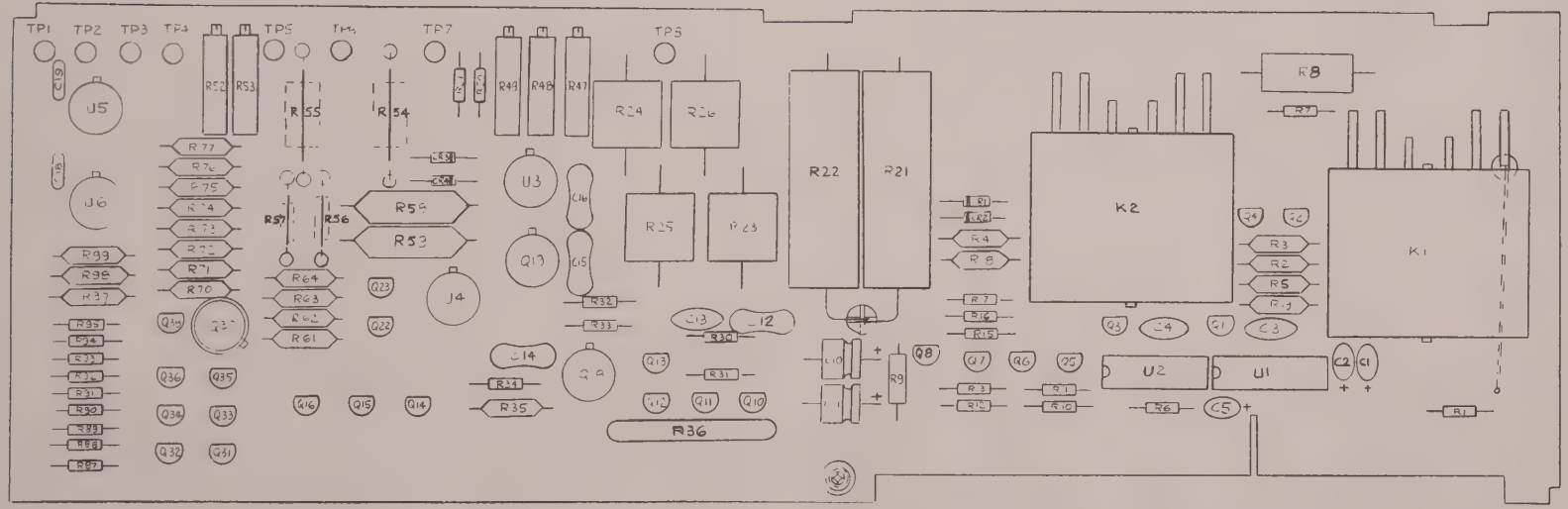


Figure 8-12. Reference Designation,
D.C. Signal Cond. Assembly (M.I.S.-1700)

BINDING POST INPUT					
GAIN	RANGE	ID3	ID2	ID1	ID0
x 64	325 mV	0	1	0	0
x 8	2.5 V	0	1	0	0
x 1	20 V	0	1	0	0
÷ 8	60 V	0	1	0	0
÷ 64	1280 V	1	1	0	0

INTERBUS INPUT (RT2)					
x 64	325 mV	0	1	0	1
x 8	2.5 V	0	1	0	1
X 1	20 V	0	1	0	1

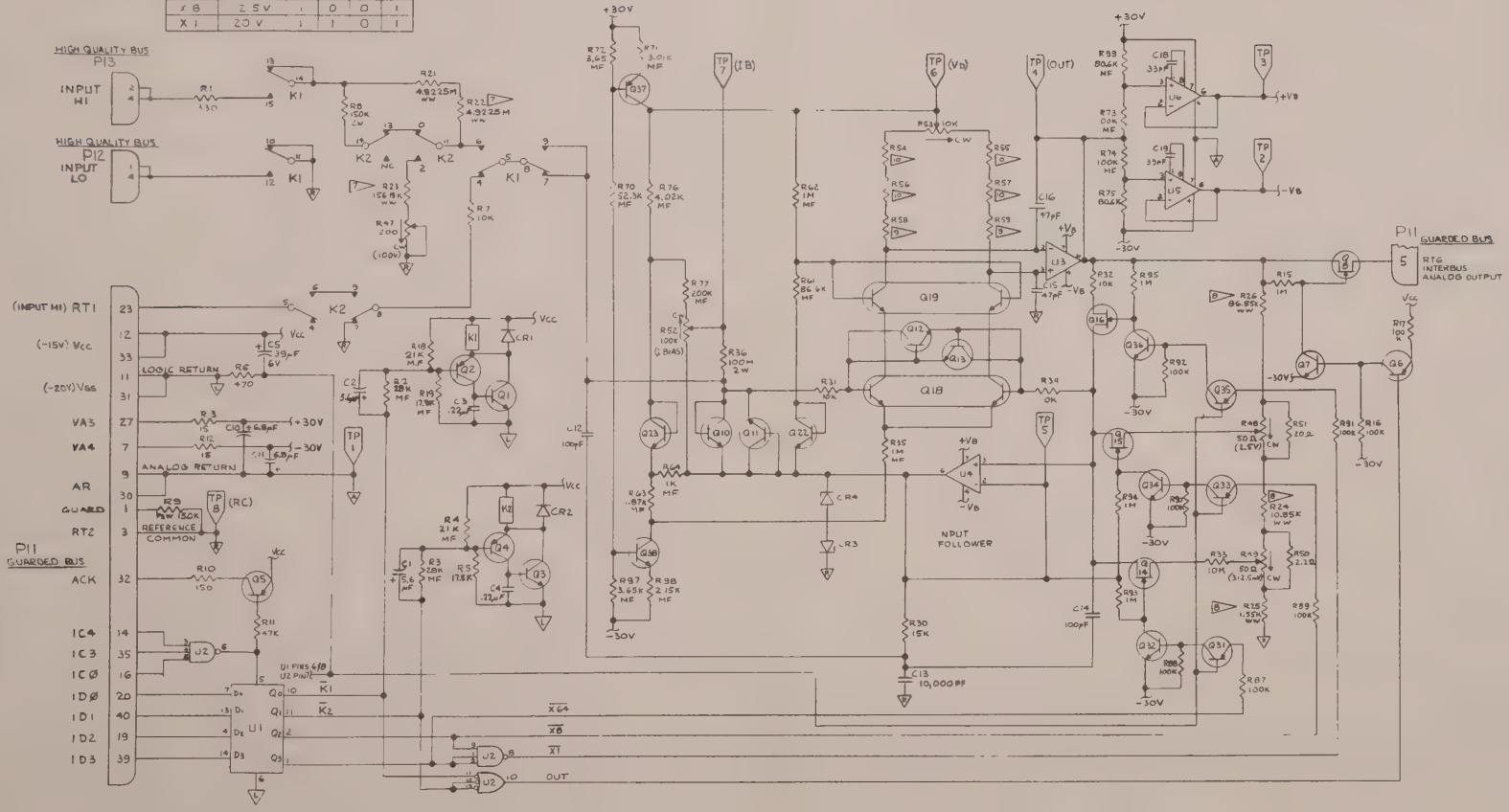
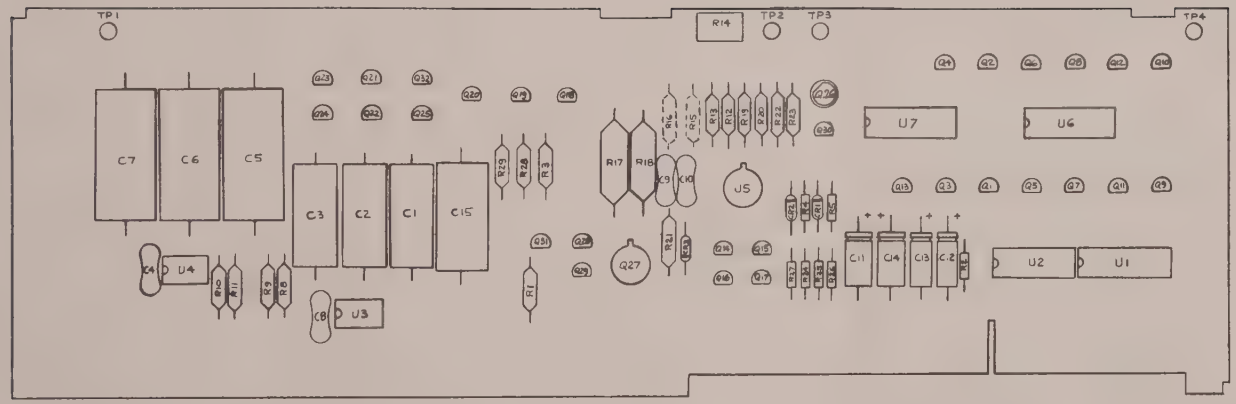


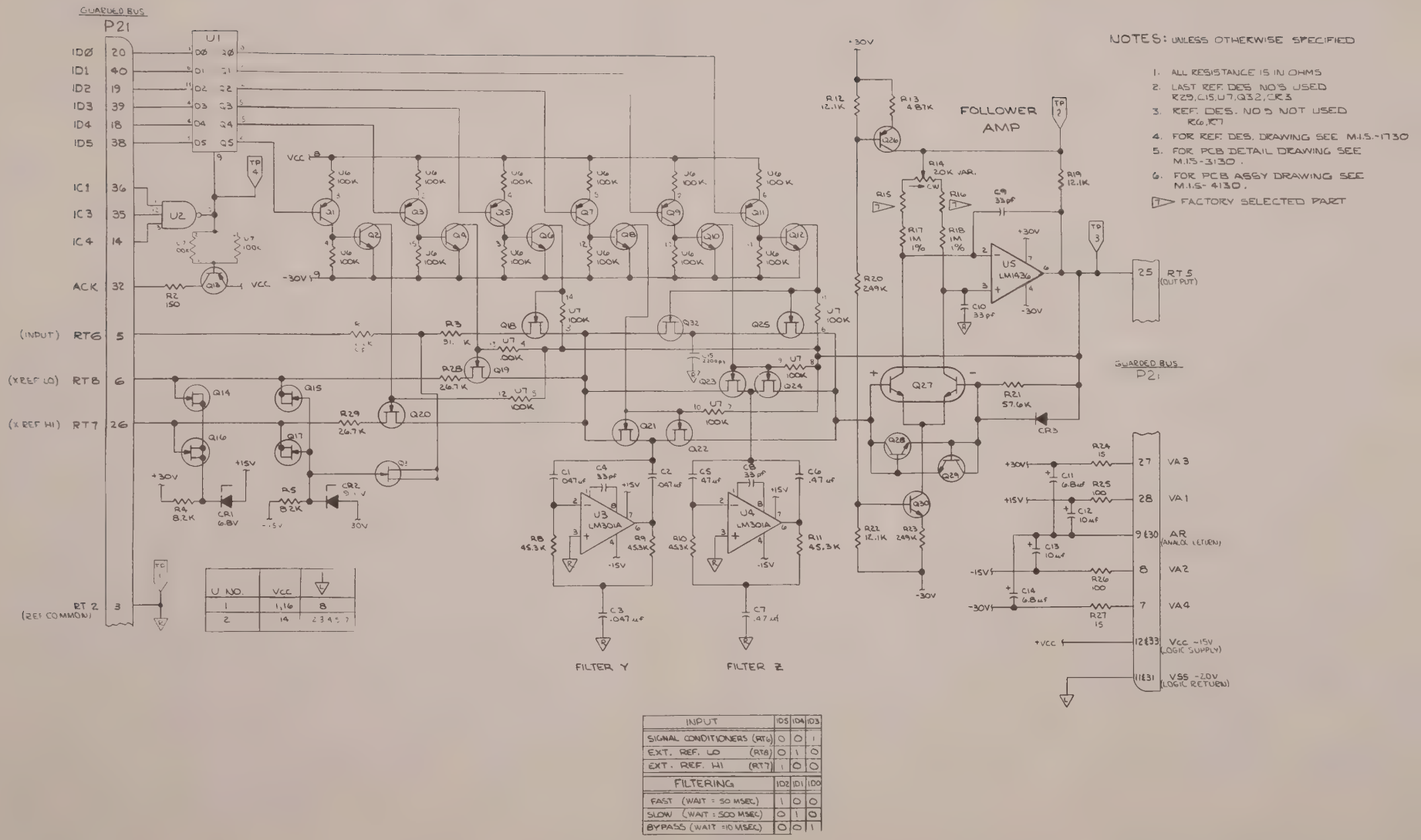
Figure 8-13. M.I.S. D.C. Signal Conditioner (M.I.S.-1100)



NOTES:

1. FOR SCHEMATIC DIAGRAM SEE MIS-1130.
2. FOR PCB SEE MIS-3130.
3. FOR ASSEMBLY SEE MIS-4130.
4. R15 & R16 WILL BE SELECTED DURING TEST.

Figure 8-14. Reference Designation,
Active Filter PCB Assembly (M.I.S.-1730)



U NO.	VCC	
1	1,16	8
2	14	4,7

INPUT	I05	I04	I03
SIGNAL CONDITIONERS (RT6)	0	0	1
EXT. REF. LO (RT8)	0	1	0
EXT. REF. HI (RT7)	1	0	0

FILTERING	I02	I01	I00
FAST (WAIT = 50 MSEC)	1	0	0
SLOW (WAIT = 500 MSEC)	0	1	0
BYPASS (WAIT = 10 MSEC)	0	0	1

Figure 8-15. Active Filter/External Reference (M.I.S.-1130)

NOTES:

1. FOR SCHEMATIC SEE M.I.S.-1141
2. FOR PCB DETAIL SEE M.I.S.-3141
3. FOR ASSY DRAWING SEE M.I.S.-4141

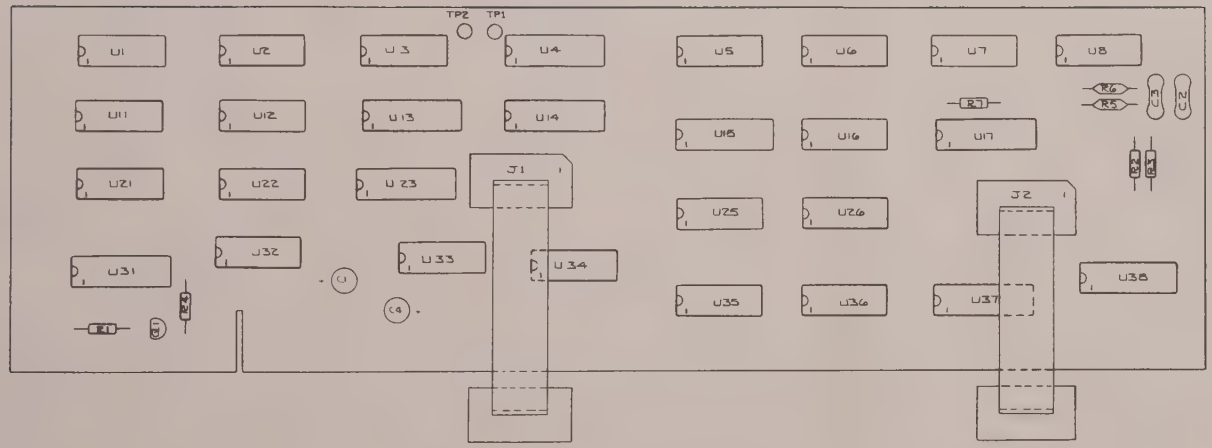


Figure 8-16. Reference Designation,
Fast R² A/D Converter (Digital) (M.I.S.-1741)

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1140.
2. FOR P.C.B. SEE M.I.S.-3140.
4. FOR ASSEMBLY DRAWING SEE M.I.S.-4140.

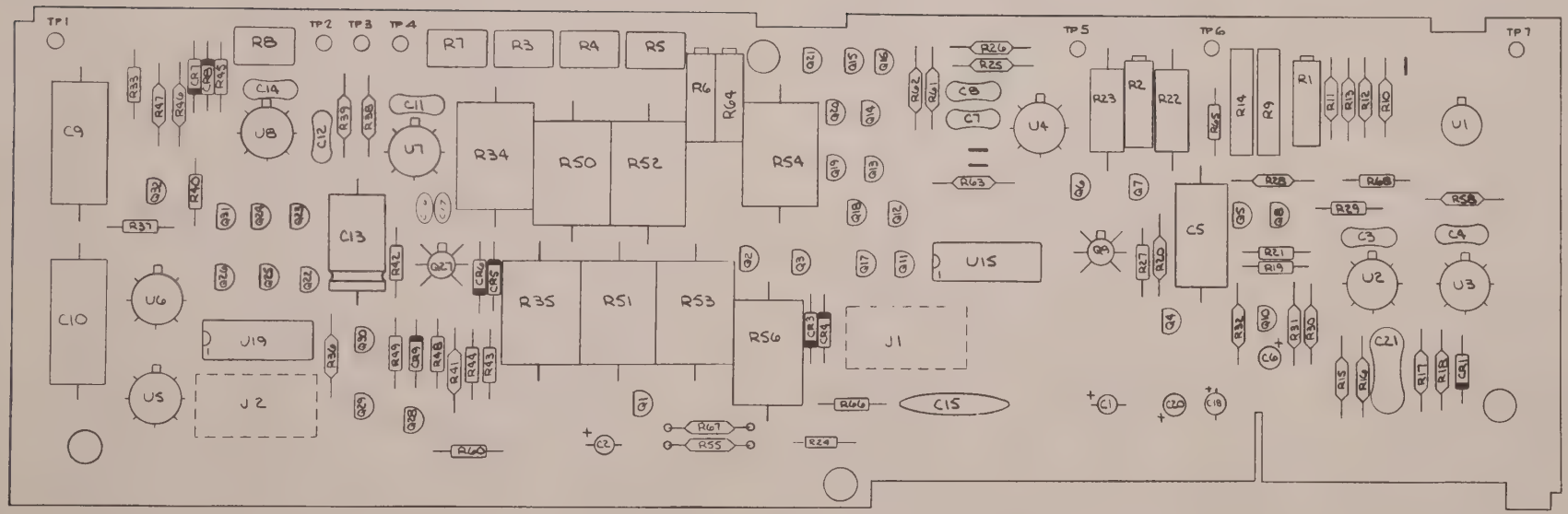


Figure 8-17. Reference Designation,
Fast R² A/D Converter (Analog) (M.I.S.-1740)

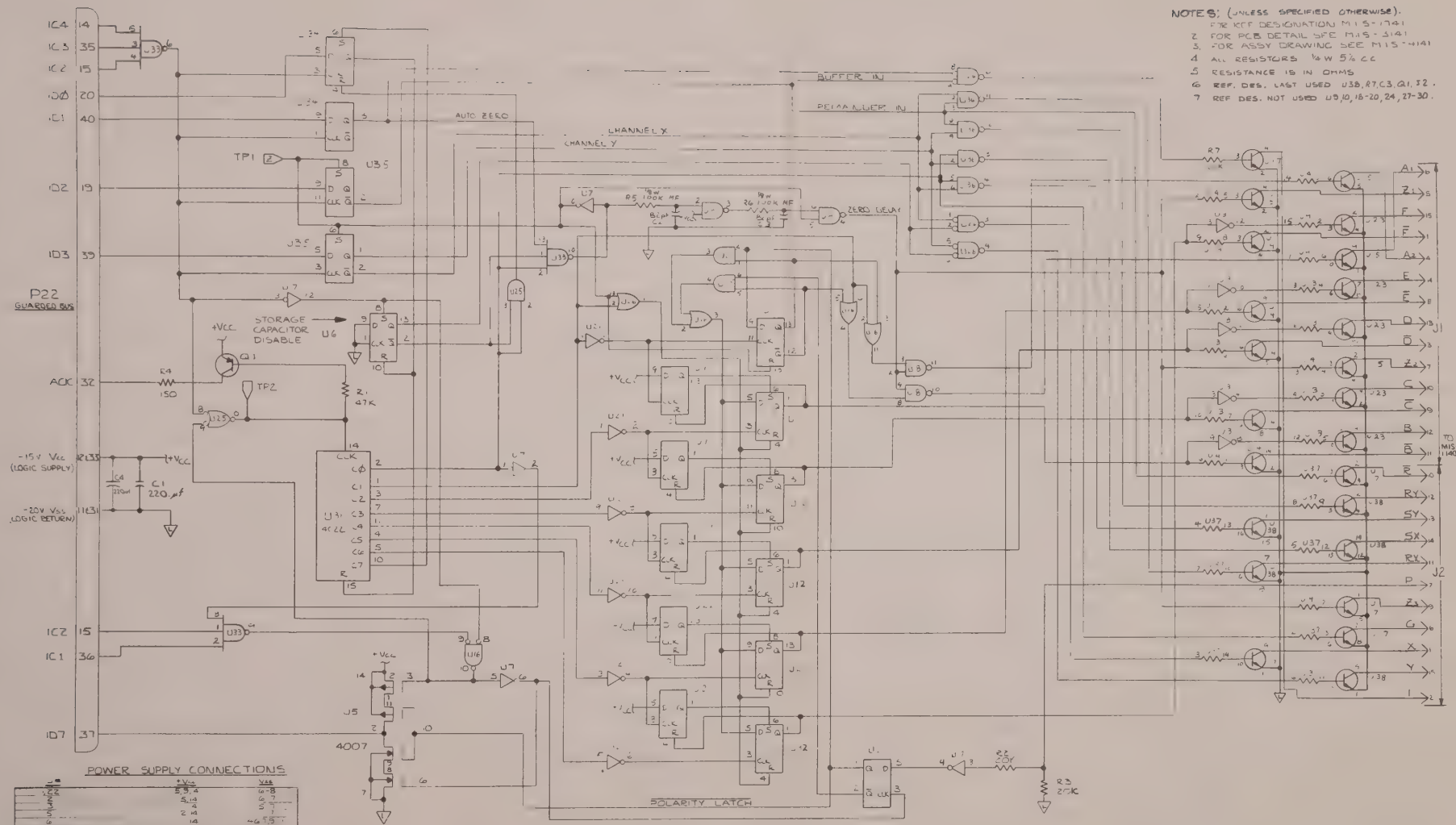


Figure 8-18. Fast R² A/D (Digital) (M.I.S.-1141)

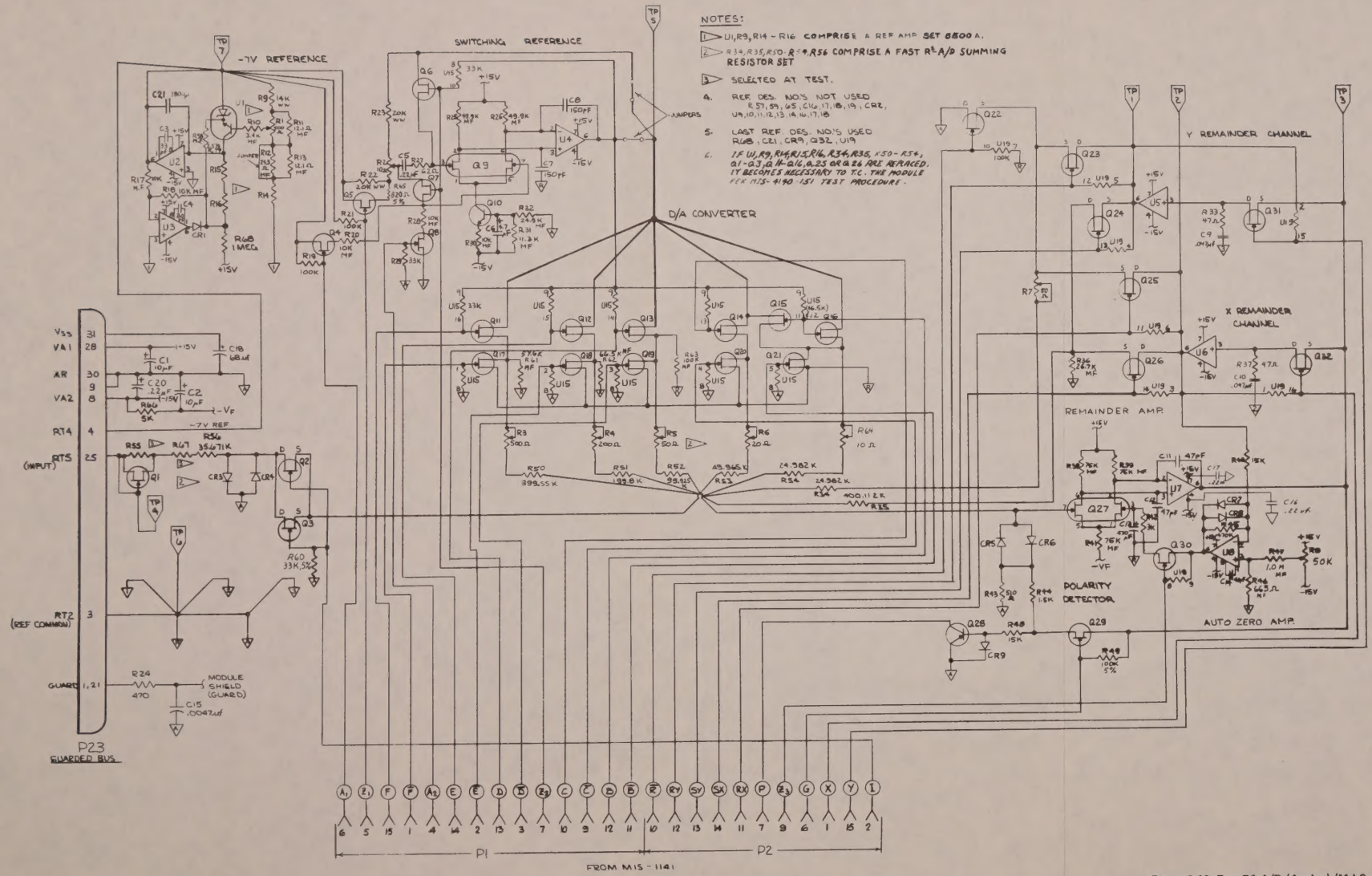

NOTES:
1. U1, R9, R14 ~ R16 COMPRISE A REF AMP SET 8500 A.
2. R34, R35, R50 - R54, R56 COMPRISE A FAST R² A/D SUMMING RESISTOR SET
3. SELECTED AT TEST.
4. REF DES. NO'S NOT USED R 57, 59, 65, C16, 17, 18, 19, CR2, U9, 10, 11, 12, 13, 14, 16, 17, 18
5. LAST REF DES. NO'S USED R68, C21, CR9, Q32, U19
6. IF U1, R9, R14, R15, R16, R34, R35, R50 - R54, Q1 - Q3, Q11 - Q16, Q25 OR Q26 ARE REPLACED, IT BECOMES NECESSARY TO T.C. THE MODULE PER MIS-1140-1S1 TEST PROCEDURE.
-7V REFERENCE
SWITCHING REFERENCE
D/A CONVERTER
JUMPERS
Y REMAINDER CHANNEL
X REMAINDER CHANNEL
REMAINDER AMP.
POLARITY DETECTOR
AUTO ZERO AMP.
-7V REF
MODULE SHIELD (GUARD)
P23
GUARDED BUS
FROM MIS-1141
P1
P2

Figure 8-19. Fast R² A/D (Analog) (M.I.S.-1140)

West Coast Paper Company

Seattle